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CONSTRUCTION QUALITY ASSURANCE PLAN

SKINNER LANDFILL SITE
BUTLER COUNTY
WEST CHESTER, OHIO

Prepared for:

Skinner Landfill Work Group
c/o Ben Baker
2020 Dow Center
Midland, MI 48764

Prepared by:

Earth Tech, Inc.
200 Vine Street
Wilder, KY 41076

FINAL
August 7, 2000

Project Number 38335

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LIST OF ACRONYMS

AMP	Air Monitoring Plan
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
BCDES	Butler County Department of Environmental Services
BZ	Breathing Zone
CD&D	Construction Debris and Demolition Waste
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CGI	Combustible Gas Indicator
CHSD	Corporate Health and Safety Director
CLP	Contract Laboratory Program
cm/sec	Centimeters Per Second
CO	Carbon Monoxide
CQA	Construction Quality Assurance
CQAC	Construction Quality Assurance Consultant
CRZ	Contamination Reduction Zone
CSDI	Contaminated Soils Design Investigation
CZ	Control Zone
DSW	Division of Surface Water (OEPA)
DSR	Division Safety Representative
EPA	Environmental Protection Agency
EZ	Exclusion Zone
FID	Flame Ionization Detector
FML	Flexible Membrane Liner (low density polyethylene)
FSP	Field Sampling Plan
ft	Feet
ft/sec	Feet Per Second
GCL	Geosynthetic Clay Layer
gpd	Gallons Per Day
gpm	Gallons Per Minute
GWDI	Groundwater Design Investigation
HAP	Hazardous Air Pollutant
HASP	Health and Safety Plan
HSM	Health and Safety Manager
IDLH	Immediately Dangerous to Life or Health
IRM	Interim Remedial Measures
kg/d	Kilograms Per Day
lb/day	Pounds Per Day
LEL	Lower Explosion Limit
MSL	Mean Sea Level
NIOSH	National Institute for Occupational Safety and Health
NO_x	Oxides of Nitrogen
NWI	National Wetland Inventory
O_3	Ozone
OAC	Ohio Administrative Code
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
ORC	Ohio Revised Code
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PID	Photoionization Detector
PLC	Programmable Logic Controller
PM-10	Particulate Matter less than 10 microns
PRP	Potentially Responsible Party
PPE	Personal Protective Equipment
psi	Pounds Per Square Inch

QAPP (QAPjP)	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RHSS	Regional Health & Safety Specialist
ROD	Record of Decision
SI	Site Inspection
SO_2	Sulfur Dioxide
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	Spill Prevention Control and Counter Measure Plan
SSO	Site Safety Officer
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
SZ	Support Zone
TDH	Total Dynamic Head
TLV	Threshold Limit Values
TSS	Total Suspended Solids
TWA	Time Weighted Average
u	Micron
ug/l	Microgram per Liter
USACE	United States Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Services
USGS	United States Geological Survey
VOC	Volatile Organic Compound
yr	Year
WBGT	Wet Bulb Globe Temperature
WZ	Work Zone

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1.0 INTRODUCTION

This Construction Quality Assurance Plan (CQAP) is prepared in conjunction with the Remedial Design for the Skinner Landfill, West Chester, Butler County, Ohio. This CQAP addresses quality assurance for construction of the final cover and installation of the groundwater interceptor system. For this CQAP, the groundwater interception system refers to the interceptor trench, cut-off wall (slurry wall), force main system and tie-in to the sanitary sewer. Extreme care and detailed documentation are required in the selection and installation of all materials used in these lining systems.

Quality assurance refers to means and actions employed to provide conformity of the remedial action with contractual and regulatory requirements. An engineer, registered in the State of Ohio, shall provide quality assurance for this Remedial Action.

Quality control refers to those actions taken to provide for materials and workmanship that meet the requirements of the design plans and specifications. The manufacturers, suppliers, contractors, and installers of the various components of the remedial action shall provide quality control.

This CQAP describes the procedures and components necessary to carefully document the construction quality control process, from the selections of materials through implementation of the remedial action. The scope of this CQAP applies to manufacturing, shipping, handling, installing, and design guidelines.

2.0 RESPONSIBILITY, AUTHORITY, AND QUALIFICATIONS

The parties discussed in this section are associated with the ownership, design, supply, manufacture, transportation, installation, and quality assurance of a lining system. The definitions, responsibilities, qualifications, and submittals of these parties are outlined in the following subsections.

2.1 Owner

The Owner is the implementor of the remedial action and is the Skinner Landfill Work Group (SLWG).

2.1.1 Responsibility and Authority

The Owner is responsible for all construction contracts. The Owner is responsible for coordinating communications with the regulatory agencies, Engineer, and Contractor for the project; and initiating the preconstruction, pre-final, and final inspections. The Owner serves as a liaison between all parties involved in construction to see that communications are maintained.

The Owner has the ultimate responsibility to ensure that the remedial action is constructed in accordance with the design plans and specifications.

2.1.2 Qualifications

The Owner's representative has direct responsibility to represent the Implementor.

2.1.3 Submittals

The Owner is responsible for submitting required information to the U.S. Environmental Protection Agency (U.S. EPA) and the Ohio Environmental Protection Agency (OEPA). Submittals include:

- Design drawings and specifications;
- Progress reports;
- Record drawings; and
- Construction Completion Report.

2.2 Project Manager

The Owner has designated Mr. Ben F. Baker as the representative for the construction activities.

2.2.1 Definitions

The Project Manager is the official representative of the Owner. In this manual, the term Project Manager shall apply equally to "Construction Coordinator", defined as the individual who coordinates construction and quality assurance activities for the project.

2.2.2 Responsibilities

The Project Manager is responsible for coordination of all construction quality assurance activities. The Project Manager is responsible for the organization and implementation of the CQAP for the project. Other responsibilities include selection or approval of Earthwork Contractor, Geosynthetic Installer, Groundwater Interception System Contractor, Quality Assurance Consultant and the Quality Assurance Laboratory.

The Project Manager shall serve as communications coordinator for the project, initiating the resolution, pre-construction, construction, and final meetings outlined in Section 3.0. As communications coordinator, the Project Manager shall serve as a liaison between all parties involved in the project to ensure that communications are maintained. The Project Manager shall also be responsible for proper resolution of all quality assurance issues that arise during construction.

2.2.3 Qualifications

The selection of the Project Manager is the direct responsibility of the Owner. Qualifications for this position include familiarity with the following:

1. Sections of this CQAP or other applicable CQAPs;

2. General earthwork construction techniques;

3. General geosynthetic installation techniques;

4. Groundwater interception system techniques;

5. Slurry wall installation technique;

6. All applicable regulatory requirements; and

7. Owner policies and procedures for project management.

2.3 Design Engineer

2.3.1 Definitions

The Design Engineer will be Laura Niemann, P.E. of Earth Tech (former Rust office) and is the individual and/or firm who prepares the design, including project plans and specifications for the lining system and groundwater interception system and will be consulted for proposed design/specification changes.

2.3.2 Responsibilities

The Design Engineer is responsible for performing the engineering design and preparing the associated project plans and specifications for the groundwater interception system and landfill cover system. The Design Engineer is responsible for approving all design and specification changes and making design clarifications necessitated during construction of the lining system. Upon the request of the Project Manager, the Design Engineer shall attend the resolution and pre-construction meetings.

2.3.3 Qualifications

The Design Engineer shall be certified or licensed in the State of Ohio and as required by regulation. The Design Engineer shall be familiar with the use of soils and/or geosynthetics, groundwater interception systems, including detailed design methods and procedures as well as slurry trench methods. In addition, the Design Engineer should be familiar with applicable regulatory requirements.

2.3.4 Submittals

The Design Engineer shall submit the project plans, specifications and associated engineering reports to the Project Manager. The Design Engineer shall also submit completed design clarification forms to the Project Manager in a timely manner upon request. Other information may also be required by the Owner.

2.4 Geosynthetics Manufacturer

2.4.1 Definitions

The Geosynthetics Manufacturers are the firms which produce any of the various geosynthetic lining system components outlined in this CQAP. In the case of a geocomposite, the Geosynthetics Manufacturer is the firm which combines the components into the final product. The manufacturers have been identified as follows:

GCL: Colloid Environmental Technologies Company (CETCO)
FML: Agru/America, Inc.
Geocomposite: Skaps Industries

2.4.2 Responsibilities

Each Geosynthetics Manufacturer is responsible for the production of its geosynthetic product. In addition, each Geosynthetics Manufacturer is responsible for the condition of the geosynthetic product until the material is accepted by the Project Manager upon delivery. Each Geosynthetics Manufacturer shall produce a consistent product that meets the project specifications. Each Geosynthetics Manufacturer shall provide quality control documentation for its product as specified in this CQAP.

2.4.3 Qualifications

Each Geosynthetics Manufacturer shall:

1. Be pre-qualified and approved by the Owner;

2. Provide sufficient production capacity and qualified personnel to meet the demands of the project; and

3. Have an internal quality control program for its product that meets the requirements presented in this CQAP.

2.4.4 Submittals

Pre-qualification: At a minimum, the Geosynthetics Manufacturer shall meet the following requirements and submit the following information to the Project Manager to be considered for pre-qualification:

1. Corporate background and information;

2. Manufacturing capabilities:

    a. Information on plant size, equipment, personnel, number of shifts per day, and capacity per shift.
    b. Daily production quantity of the specified product available for the Owner's facilities.
    c. A list of material properties including certified test results with attached geosynthetic samples.
    d. A list of at least 15 large landfill projects, for which the Geosynthetics Manufacturer has manufactured a geosynthetic. For each facility, the following information shall be provided:

        (1) Name and purpose of facility, its location and date of installation;
        (2) Name of Owner, Project Manager, Design Engineer, Installer and Fabricator (if any);
        (3) Type of geosynthetic and surface area of geosynthetic manufactured; and
        (4) Available information on the performance of the lining system;

3. The Geosynthetics Manufacturer's quality control manual, including a description of the quality control laboratory facilities; and

4. The origin (supplier's name and production plant) and identification (brand name and number) of resin used to manufacture the product.

Additional information may need to be submitted if requested by the Project Manager.

Pre-installation: Prior to the installation of any geosynthetic material, the Geosynthetics Manufacturer shall submit to the Project Manager all quality control documentation required by the appropriate section of this CQAP. This documentation shall be reviewed by the Geosynthetic Quality Assurance Consultant before installation can begin.

2.5 Interception Trench System Manufacturer

2.5.1 Definitions

The Manufacturer is the firm which produces any of the various groundwater interception system components outlined in this CQAP and will be identified upon procurement.

2.5.2 Responsibilities

Each Manufacturer is responsible for the production of its product. In addition, each Manufacturer is responsible for the condition of the product until the material is accepted by the Project Manager upon delivery. Each Manufacturer shall produce a consistent product that meets the project specifications. Each Manufacturer shall provide quality control documentation for its product as specified in this CQAP.

2.5.3 Qualifications

Each Manufacturer shall:

1. Be pre-qualified and approved by the Owner.

2. Provide sufficient production capacity and qualified personnel to meet the demands of the project.

3. Have an internal quality control program for its product that meets the requirements presented in this CQAP.

2.5.4 Submittals

Pre-qualification: At a minimum, the Manufacturer shall meet the following requirements and submit the following information to the Project Manager to be considered for pre-qualification:

1. Corporate background and information.

2. Manufacturing capabilities:

    a. Information on plant size, equipment, personnel, number of shifts per day, and capacity per shift.
    b. Daily production quantity of the specified product available for the Owner's facilities.
    c. A list of material properties including certified test results with attached samples.

3. The Manufacturer's quality control manual, including a description of the quality control laboratory

facilities.

Additional information may need to be submitted if requested by the Project Manager.

Pre-installation: One month prior to the installation of any geosynthetic material, the Manufacturer shall submit to the Project Manager all quality control documentation required by the appropriate section of this CQAP. This documentation shall be reviewed by the Quality Assurance Consultant as outlined in Section 2.9 of this CQAP before installation can begin.

2.6 Earthwork Contractor

2.6.1 Definitions

The Earthwork Contractor is the firm which performs the site earthwork preparation and construction of the soil components of the lining system and will be Earth Tech. The Construction Manager is the official representative of the Earthwork Contractor. Mr. Rick Warwick will be the Construction Manager. The Earthwork Superintendent is the individual responsible for the Earthwork Contractor's field crew and will report to the Construction Manager. The Earthwork Superintendent will be Tim Meade and will represent Earth Tech at all site meetings and acts as the Earthwork Contractor's spokesman on the project.

2.6.2 Responsibilities

The Earthwork Contractor is responsible for constructing soil components of the lining systems in conformance to the project plans and specifications. The Earthwork Contractor is also responsible for locating and transporting the required earth and granular materials, concrete, piping, and other work, as outlined in the project specifications.

2.6.3 Qualifications

The Earthwork Contractor shall be:

1. Pre-qualified and approved by the Owner;

2. Able to demonstrate experience on a similar project; and

At a minimum, the Earthwork Contractor shall provide an Earthwork Superintendent as described below.

The Earthwork Superintendent must be qualified based on previously demonstrated experience, management ability, and authority. The Earthwork Superintendent shall be approved by the Project Manager.

2.6.4 Submittals

Pre-qualification: At a minimum, the Earthwork Contractor shall meet the following requirements and submit the following information to the Project Manager to be considered for prequalification:

1. Company background and information;

2. Demonstration of bonding and insurance capability;

3. List of outstanding contracts;

4. List of readily available equipment required to perform the work (i.e., scrapers, graders, scarifiers, compactors, discing equipment, water trucks, and admixing equipment, if required); and

5. List of at least five comparable projects with the following information for each project:

   a. Name of the facility, its location, date of installation;
   b. Name of project manager or contact person for the installation;
   c. Description and purpose of installation and definition of contractor's scope of work; and

Additional information may need to be submitted if requested by the Project Manager.

Pre-installation: Prior to commencement of the earthwork activities, the Earthwork Contractor shall submit to the Project Manager:

1. Resume of the Earthwork Superintendent to be assigned to this project, including the dates and duration of employment;

2. Schedule of construction activities.

3. List of specific equipment and personnel to be used on the project.

Installation: During the installation, the Earthwork Contractor shall submit to the Project Manager:

1. Subgrade acceptance certificates for each area to be covered by the lining system signed by the Earthwork Contractor.

Completion: Upon completion of the installation, the Earthwork Contractor shall submit a Certificate of Completion.

2.7 Geosynthetic Installation Contractor

2.7.1 Definitions

The Geosynthetic Installation Contractor (Installer) is the firm which installs the geosynthetic components of the lining system and will be MidAmerica Lining Systems, Inc. The Geosynthetic Superintendent is the individual responsible for the Installer's field crew. The Geosynthetic Superintendent shall represent the Installer at all site meetings and act as the Installer's spokesman on the project. The Master Seamer shall be an experienced seamer on the Installer's field crew who shall provide direct supervision over less experienced seamers.

2.7.2 Responsibilities

The Installer is responsible for field handling, storing, deploying, seaming, temporary restraining and all other aspects of the geosynthetics installation. The Installer may also be responsible for transportation of

these materials to the site and for anchor systems, if required by the project specifications. The Installer shall be responsible for submittal of the documentation listed in Section 2.6.4.

2.7.3 Qualifications

The Installer shall be pre-qualified and approved by the Owner. The Installer shall be able to provide qualified personnel to meet the demands of the project. At a minimum, the Installer shall provide a Geosynthetic Superintendent and a Master Seamer.

The Geosynthetic Superintendent shall be qualified based on previously demonstrated experience, management ability and authority. The Geosynthetic Superintendent shall be approved by the Project Manager.

For geomembrane installation, all personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. The Master Seamer shall have experience seaming a minimum of 1,000,000 ft^2 of polyethylene geomembrane using the same type of apparatus to be used at the site and be approved by the Project Manager.

2.7.4 Submittals

Pre-qualification: At a minimum, the Installer shall submit the following information to the Project Manager to be considered for pre-qualification:

1. Corporate background and information.

2. Description of installation capabilities:

    a. Information on equipment (numbers and types), and personnel (number of Superintendents, number of crews).
    b. Average daily production anticipated.
    c. Samples of field geomembrane seams and a list of minimum values for geomembrane seam properties.

3. A list of at least ten completed facilities, totalling a minimum of 2,000,000 ft^2 (200,000 m^2) for which the Installer has installed geosynthetics. For each installation, the following information shall be provided:

    a. Name and purpose of facility, its location, and date of installation.
    b. Name of owner, project manager, design engineer, geosynthetic manufacturer, fabricator (if any), and name of contact at the facility who can discuss the project.
    c. Name and qualifications of the Superintendent(s) of the Installer's crew(s).
    d. Type of geosynthetic, and surface area installed.
    e. Type of seaming and type of seaming apparatus used.
    f. Duration of installation.
    g. Available information on the performance of the lining system.

4. The Installer's quality control manual.

5. A copy of a letter of recommendation supplied by the geomembrane manufacturer.

Pre-installation: Prior to commencement of the installation, the Installer must submit to the Project Manager:

1. Resume of the Geosynthetic Superintendent to be assigned to this project, including dates and duration of employment.

2. Resume of the Master Seamer to be assigned to this project, including dates and duration of employment.

3. A panel layout drawing showing the installation layout identifying field seams as well as any variance or additional details which deviate from the project plans or specifications. The layout shall be adequate for use as a construction plan and shall include dimensions and details as appropriate.

4. Installation schedule.

5. A list of personnel performing field seaming operations along with pertinent experience information.

6. All geosynthetic quality control certificates as required by this CQAP, unless submitted directly to the Project Manager by the Geosynthetics Manufacturer.

7. Certification that extrudate to be used is comprised of the same resin as the geomembrane to be used.

This documentation shall be reviewed by the Geosynthetic Quality Assurance Consultant before installation of the geosynthetic can begin.

Installation: During installation, the Installer shall be responsible for the submission of:

1. Quality control documentation recorded during installation.

2. Subgrade surface acceptance certificates signed by the Installer for each area to be covered by the lining system.

Completion: Upon completion of the installation, the Installer shall submit:

1. The warranty obtained from the Geosynthetics Manufacturer.

2. The installation warranty.

2.8 Groundwater Interceptor System Contractor

2.8.1 Definitions

The Contractor is the firm which performs the site earthwork preparation and construction of the

groundwater interception system including the interceptor trench and slurry wall. The Contractor for this portion of the work will be Pro Terra, Inc. The Superintendent is the individual responsible for the Contractor's field crew. The Superintendent represents the Contractor at all site meetings and acts as the Contractor's spokesman on the project.

2.8.2 Responsibilities

The Contractor is responsible for constructing components of the lining systems in conformance to the project plan and specifications. The Contractor may also be responsible for locating and transporting the required earth and granular materials, concrete, piping, and other work, as outlined in the project specifications.

2.8.3 Qualifications

The Contractor shall be:

1. Pre-qualified and approved by the Owner;

2. Able to provide qualified personnel to meet the demands of the project; and

At a minimum, the Contractor shall provide a Superintendent as described below.

The Superintendent must be qualified based on previously demonstrated experience, management ability, and authority. The Superintendent shall be approved by the Project Manager.

2.8.4 Submittals

Pre-qualification: At a minimum, the Contractor shall meet the following requirements and submit the following information to the Project Manager to be considered for prequalification:

1. Company background and information;

2. Demonstration of bonding and insurance capability;

3. List of outstanding contracts;

4. List of readily available equipment required to perform the work (i.e., scrapers, graders, scarifiers, compactors, discing equipment, track hoes, water trucks, and admixing equipment, if required); and

5. List of at least five comparable projects with the following information for each project:

    a. Name of the facility, its location, date of installation;
    b. Name of project manager or contact person for the installation; and
    c. Description and purpose of installation and definition of contractor's scope of work.

Additional information may need to be submitted if requested by the Project Manager.

Pre-installation: Prior to commencement of the construction activities, the Contractor shall submit to the Project Manager:

1. Resume of the Superintendent to be assigned to this project, including the dates and duration of employment;

2. Schedule of construction activities; and

3. List of specific equipment and personnel to be used on the project.

Installation: Following the installation, the Contractor shall submit to the Project Manager:

1. Upon completion of the installation, the Contractor shall submit a Certificate of Completion

2.9 Construction Quality Assurance Consultant/Engineer

2.9.1 Definition

The Construction Quality Assurance (CQA) Consultant/Engineer is the firm/individual responsible for confirming the work is performed to the project plans and specifications, and assembling the record of the work. The CQA Consultant is the firm or project representatives (Resident Project Observers, RPO), that work under the direction of the CQA Engineer. Earth Tech will be the CQA Consultant firm. The CQA Engineer is a registered Professional Engineer licensed to practice in the State of Ohio. The CQA Engineer will be Ron Roelker, P.E.

2.9.2 Responsibility and Authority

The CQA Engineer is responsible for:

- Assigning quality assurance personnel to observe and document construction activities, requiring certification.
- Preparing a Construction Completion Report as outlined in Section 4.0 - Documentation, of this CQAP.
- Overseeing the geotechnical and geosynthetic laboratory testing and the testing of materials for the groundwater interception system.
- Review the calibration certificates of testing equipment.
- Establishing a program of quick and ready access to the Project Manager at all times. Communications shall be frequent, and the lines of communication shall be followed as established at the preconstruction meeting.

The CQA Engineer and/or the RPO is responsible for:

- Reviewing the results of geotechnical and geosynthetic laboratory testing.
- Verifying that installation requirements are met and that all submittals are provided.
- Performing and repeating tests, as necessary, to provide a high degree of certainty that the physical/mechanical characteristics of the earthwork components of the landfill cover system meet or exceed specifications.
- Attending all quality assurance related meetings, including pre-construction and weekly.

The RPO is responsible for:

- Maintaining field filing system and providing copies to the CQA Engineer.
- Acting as on-site (resident) representative to the CQA Engineer.
- Observing and recording activities related to the construction of the remedial action.
- Implementing the field sampling and testing components of this CQAP.
- Preparing a daily summary of quantity estimates (soil, geosynthetics and other materials).
- Observing and recording the activities of the Contractor to ensure that the work product complies with the remedial design plans and specifications. Keeping a photo log of project activities with dates accurate and up-to-date.
- Maintaining daily reports of construction and quality control activities as outlined in Section 4.1 of this CQAP. Construction reports summarizing significant events, as well as addressing problems encountered and their solutions, shall be documented. The RPO shall submit these daily reports to the CQA Engineer.
- Preparing a weekly summary of construction activities at the end of each week.

Any differences between the CQA Engineer's interpretation of the remedial design plans and specifications from the Contractor's or Project Manager's interpretation shall be resolved by the Design Engineer.

If such assessment indicates any actual or suspected work deficiencies, the CQA Engineer shall inform the Project Manager and the Contractor of these deficiencies.

2.9.3 Qualifications

The CQA Consultant, Engineer and RPO shall be experienced in the installation of landfill covers, and groundwater interception systems and the procedures of quality assurance documentation including quality assurance forms, reports, and record drawings. The CQA Engineer shall be a licensed professional engineer in the State of Ohio.

2.9.4 Submittals

The CQA Engineer, in conjunction with the Design Engineer, shall be responsible for submitting the Construction Completion Report to the Owner and U.S. EPA. The RPO shall be responsible for submitting daily field reports to the CQA Engineer and compiling information for the Construction Completion Report throughout the construction period.

The CQA Engineer will summarize activities of the past week indicating problems encountered and their resolution, delays and anticipated activities that require CQA involvement for the upcoming week. These items will be presented in a weekly report to the Project Manager.

2.10 Interceptor Trench Quality Assurance Consultant

2.10.1 Definitions

The Interceptor Trench Quality Assurance Consultant (QAC) is the firm which observes and documents activities related to the quality assurance of the installation of the groundwater interception system on behalf of the Owner and will be the same entity as the CQA consultant.

In this CQAP, the term CQA Engineer refers to the engineer employed by the CQA Consultant who is personally in charge of the quality assurance work. In some cases, the duties of the CQA Engineer may be shared by two individuals: the CQA Engineer and the RPO. Although not located at the site, the CQA Engineer shall visit the site often enough to be familiar with the details of the project. The CQA Engineer may also be known as the Quality Assurance Officer.

The personnel of the QAC may also include Quality Assurance Monitors (QA Monitors) who are located at the site for construction observation and documentation. Quality Assurance Engineer may also serve as quality assurance monitor.

The CQA Consultant may be referred to as Geosynthetics QAC for quality assurance activities associated with geosynthetics. This is an attempt to indicate the different areas of expertise required by the CQA Consultant. A similar designation will be used for groundwater interception system QAC.

2.10.2 Responsibilities

The QAC is responsible for observing and documenting activities related to the quality assurance of the construction of the components of the groundwater interception system. The QAC is responsible for the implementation of this project CQAP. The QAC is also responsible for issuing a final Quality Assurance Report, sealed by a licensed Professional Engineer, as outlined in Section 2.0 of this CQAP. Other duties of the QAC shall include overseeing the laboratory testing.

The specific duties of the QAC personnel are as follows:

1. The QAE:

a. Reviews all project plans and specifications.
b. Reviews other site-specific documentation.
c. Develops site-specific addenda for quality assurance of components with the assistance of the Project Manager as necessary.
d. Administers the CQAP, including assigning and managing all quality assurance personnel, reviews all field reports, and provides engineering review of all quality assurance related issues.
e. Familiarizes himself with all applicable changes to project plans and specifications as issued by the Designer.
f. Acts as on-site representative of the QAC.
g. Familiarizes all QA Monitors with the site and the project CQAP.
h. Assigns QA Monitors to observe and document all activities requiring monitoring.
i. Attends all quality assurance related meetings, including resolution, pre-construction, daily, weekly meetings.
j. Reviews the Contractor's personnel qualifications for conformance with those qualifications pre-approved for work on-site.
k. Reviews the calibration certification of the on-site and off-site testing equipment.
l. Manages the preparation of the record drawings.
m. Reviews the QA Monitors' daily reports, logs, and photographs.
n. Notes any on-site activities that could result in damage to the installed components.
o. Reports to the Project Manager, and logs in the daily report, any relevant observations reported by the QA Monitors.
p. Prepares his own daily report.
q. Prepares a daily summary of the component quantity estimates installed each day of construction activity.
r. Prepares a weekly summary of quality assurance activities at the end of each week of the construction activity.
s. Oversees marking, packaging and shipping of all laboratory test samples (if required).
t. Reviews the results of laboratory testing and makes appropriate recommendations.
u. Recommends the approval of the final acceptance of the groundwater interception system to the Project Manager.
v. Designates a QA Monitor to be his representative whenever he is absent from the site while operations are ongoing.
w. Reports any unapproved deviations from the CQAP to the Project Manager.
x. Maintains field files of all logs and reports.
y. Maintains qualifications of all personnel and calibration of equipment.
z. Prepares the final Quality Assurance Report.

2. The QA Monitor:

a. Monitors, logs, photographs and/or documents all component installation operations. Photographs shall be taken routinely and in critical areas of the installation sequence. These duties shall be assigned by the QAE.
b. Monitors and documents the following operations for all components:
   (1) Material delivery
   (2) Unloading and on-site transport and storage
   (3) Sampling and conformance testing
   (4) Deployment operations

(5) Condition of the components as placed
(6) Visual observation, by walkover, of the finished components
(7) Repair operations, if and when necessary

c. Conducts sampling and testing.
d. Documents any on-site activities that could result in damage to the constructed components. Any problems noted shall be reported as soon as possible to the QAE.

Any differences of the QAC's interpretation of the project plans and specifications from the Contractor's interpretation shall be properly and adequately assessed by the QAC through discussion with the Contractor. If such assessment indicates any actual or suspected work deficiencies, the QAC shall inform the Contractor of these issues.

2.10.3 Qualifications

The QAC shall be pre-qualified and approved by the Owner. The QAC shall be experienced in the preparation of quality assurance documentation including quality assurance forms, reports, certifications and manuals.

The QAE shall hold a B.S., M.S., or Ph.D. degree in civil engineering or related fields and be licensed as a Professional Engineer in the State of Ohio. If the duties of the QAE are shared by two parties, only the Quality Assurance Certifying Engineer shall be required to be a licensed Professional Engineer in the State of Ohio. The QAE shall be specifically experienced in the installation of groundwater interception system and shall have the necessary training and certifications to perform the duties of a QAE. The QAE shall be approved by the Project Manager.
QA Monitors shall have specific training in construction quality assurance of engineered features and be so designated by the QAE. The Monitors shall also be approved by the Project Manager.

2.10.4 Submittals

Pre-qualification: At a minimum, the QAC shall submit the following information in writing to the Project Manager to be considered for pre-qualification:

1. Corporate background and information:

    a. General company information
    b. Proof of insurance
        (1) Professional liability
        (2) "Umbrella" coverage
        (3) Other coverages as required by statute and/or proposed contractual agreement; and

2. Quality assurance capabilities:

    a. A summary of the firm's experience in quality assurance, specifically quality assurance of groundwater interception system.
    b. A summary of quality assurance documentation and methods used by the firm, including sample quality assurance forms, reports, certifications, and manuals prepared by the firm.
    c. Resumes of key personnel.

Additional information may need to be submitted if required by the Project Manager.

2.11 Geotechnical Quality Assurance Laboratory

2.11.1 Definitions

The Geotechnical Quality Assurance Laboratory (Geotechnical QAL) is the firm which conducts tests on soil samples taken from the site and will be the H.C. Nutting Company. The Geotechnical QAL and Geosynthetic QAL will the same party.

2.11.2 Responsibilities

The Geotechnical QAL is responsible for conducting the appropriate laboratory tests as directed by the CQA Engineer. The test procedures shall be performed in accordance with the test methods outlined in this CQAP. The Geotechnical QAL shall be responsible for providing tests results as outlined in Section 2.11.4.

2.11.3 Qualifications

The Geotechnical QAL shall be pre-qualified by the Owner and approved by the Project Manager. The Geotechnical QAL shall have properly maintained and periodically calibrated appropriate testing equipment. The Geotechnical QAL shall also ensure that laboratory soil testing is performed by personnel with experience and/or training in soil testing fundamentals. The laboratory personnel shall be familiar with American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), Federal Test Method Standard (FTMS) and other applicable test standards. The Geotechnical QAL shall be capable of providing test results
within project deadlines throughout the soil prequalification, installation phase of the soil components and well installation.

The Geotechnical QAL shall submit sample data and analysis to be used during the lab tests to the Project Manager.

2.11.4 Submittals

The Geotechnical QAL shall submit all written test results within project deadlines to the CQA Engineer. Test results shall be provided to the CQA Engineer within 48 hours after test completion. Written test results shall be in an easily readable format and include references to the standard test methods used.

2.12 Geosynthetic Quality Assurance Laboratory

2.12.1 Definitions

The Geosynthetic Quality Assurance Laboratory (Geosynthetic QAL) is the firm which conducts tests on samples of geosynthetics taken from the site and will be the H.C. Nutting Company. The Geosynthetic QAL and the Geotechnical QAL may be the same party.

2.12.2 Responsibilities

The Geosynthetic QAL is responsible for conducting the appropriate laboratory tests as directed by the CQA Engineer. The test procedures shall be done in accordance with the test methods outlined in this CQAP. The Geosynthetic QAL shall be responsible for providing test results as outlined in Section 2.9.4.

2.12.3 Qualifications

The Geosynthetic QAL shall be pre-qualified by the Owner and approved by the Project Manager. The Geosynthetic QAL shall have properly maintained and periodically calibrated appropriate testing equipment. The Geosynthetic QAL shall also ensure the laboratory testing is performed by personnel with experience and/or training in geosynthetic testing fundamentals.

The Geosynthetic QAL shall be familiar with ASTM, FTMS, National Sanitation Foundation (NSF), and other applicable test standards. The Geosynthetic QAL shall be capable of providing results of destructive seam tests within 24 hours of receipt of test samples and shall maintain that standard throughout the installation. On-site laboratory facilities may be used by the Geosynthetic QAL, provided they are appropriately equipped and approved by the CQA Engineer and Project Manager.

2.12.4 Submittals

The Geosynthetic QAL shall submit all destructive seam test results to the CQA Engineer in written form within 48 hours of receipt of test samples unless otherwise specified by the Project Manager. Geomembrane destructive test results shall typically be provided to the CQA Engineer within 24 hours of receipt of test samples. Written test results shall be in an easily readable format and include references to the standard test methods used.

3.0 MEETINGS AND COMMUNICATION

To help ensure a high degree of quality during installation and assure a final product that meets all project specifications, clear, open channels of communication are essential between all parties. This section discusses appropriate lines of communication and describes all meetings that will be necessary to achieve project goals.

3.1 Lines of Communication

The typical lines of communication necessary during a project are illustrated in Appendix II. The CQA Engineer shall be capable of direct communication with the Project Manager at all times.

3.2 Resolution Meeting

Following RD approval and the completion of the project plans and specifications, a resolution meeting may be held. If the Project Manager determines a resolution meeting is necessary, it shall be held prior to bidding the construction work and include all parties involved. Typically these meetings may include the Project Manager, Design Engineer, CQA Engineer, QAE, and the Owner's representative. If appropriate, this meeting may be held in conjunction with the pre-bid meeting.

The purpose of the resolution meeting is to establish lines of communication, review project plans and specifications for completeness and clarity, begin planning for coordination of tasks and anticipate any problems which might cause difficulties and delays in construction. The design shall be discussed during this meeting so that clarification may be made before the construction work is bid. In addition, the guidelines regarding quality assurance testing and problem resolution must be known and accepted by all. Any recommended design changes will be evaluated and presented to U.S. EPA for approval.

A recommended agenda for the resolution meeting is presented in Appendix III. The meeting shall be documented by the project manager, and minutes shall be transmitted to all parties.

3.3 Pre-Construction Meeting

A pre-construction meeting shall be held at the site prior to beginning work on this project. The pre-construction meeting must be attended by the Owner, Project Manager, Design Engineer, Contractor (Earthwork Contractor and/or Geosynthetic Installation Contractor and/or Interceptor Trench Contractor and Subcontractors), CQA Engineer, RPO, and QAE, U.S. EPA, and OEPA. This CQAP shall be reviewed as well as the responsibility of each party. A recommended agenda with specific topics for the pre-construction meeting is presented in Appendix IV. The meeting shall be documented by the Project Manager and minutes shall be transmitted to all participants.

3.4 Progress Meetings

A weekly progress meeting shall be held between the Owner, Project Manager, CQA Engineer/QAE, Earthwork Contractor's/Geosynthetic Installation Contractor/Interceptor Trench Contractor, and any other concerned parties. This meeting shall discuss current progress, planned activities for the next week, issues requiring resolution, and any new business or revisions to the work. The CQA Engineer/QAE shall log any problems, decisions, or questions arising at this meeting in his weekly report. If any matter remains unresolved at the end of this meeting, the Project Manager shall be responsible for the resolution of the

matter and the communication of the decision to the appropriate parties. The Project Manager may require daily progress meetings at his discretion.

3.5 Pre-Final Meeting

As the project is nearing completion, a pre-final meeting shall be held at the site. This meeting shall be attended by the Owner, Project Manager, Contractors, Design Engineer, CQA Engineer, Interceptor Trench QAC, U.S. EPA, and OEPA. It shall consist of a walk-through of the entire project area to determine whether the project is substantially complete and consistent with the contract documents. Any outstanding construction items noted during the prefinal inspection shall be recorded. A report prepared by the Project Manager shall outline the outstanding construction items, actions required to resolve items, completion dates for these items, and the date for the final meeting. All attendees will receive a copy of the report.

3.6 Final Meeting

Upon completion of outstanding construction items, a final meeting shall be held at the site. The final meeting must be attended by the Owner, Project Manager, Contractors, Design Engineer, CQA Engineer, Interceptor Trench QAC, U.S. EPA, and OEPA. The meeting shall consist of a walk-through of the project site. The prefinal meeting report shall be used as a checklist to focus on the outstanding construction items.

4.0 DOCUMENTATION

An effective CQAP depends largely on identification of those construction activities that require monitoring, and on assigning responsibilities for the monitoring of each activity. This is most effectively verified by the thorough documentation of quality assurance activities. The CQA Engineer shall document that all requirements in the lining portions of the project CQAP have been addressed and satisfied.

The CQA Engineer shall provide the Project Manager with signed descriptive remarks, data sheets, and checklists to verify that required monitoring activities have been carried out. The CQA Consultant shall also maintain at the job site a complete file of all documents which comprise the CQAP, including plans and specifications, checklists, test procedures, daily logs, and other pertinent documents.

4.1 Daily Reports

4.1.1 Soils Reports

Each Soils RPO shall complete a daily report and/or logs on prescribed forms outlining all monitoring activities for that day. The report at a minimum shall consist of field notes, observations, test data sheets, construction problems and solution data sheets. A summary of all supporting data sheets along with final testing results and CQA Engineer's approval of the work shall be required upon completion of construction.

The Project Manager shall immediately be made aware of any nonconformance with the project specifications. In particular, the Project Manager shall be informed before the work in question is covered by overlying system layers. The Project Manager shall then determine its cause and direct appropriate changes or recommend the appropriate changes. When this type of evaluation is made the results shall be documented. Revisions to procedures or project specifications shall be approved in writing by the Owner and Design Engineer with documentation sent to the USEPA, Ohio EPA and the Earthwork Contractor.

4.1.2 Geosynthetic Reports

Each Geosynthetic RPO shall complete a daily report and/or logs on prescribed forms outlining all monitoring activities for that day. The precise areas worked on, panel numbers, seams completed and approved, measures taken to protect unfinished areas overnight and other appropriate data and information shall be identified. Failed seams, other panel areas, or other geosynthetics requiring remedial action shall be identified with regard to nature of action, required repair, and precise location. Repairs completed must also be identified as well as failing sample data. Any problems or concerns with regard to operations on site should be noted. The report should also include information regarding the weather conditions. This report must be completed at the end of each monitor's shift, prior to leaving the site, and submitted to the CQA Engineer.

The CQA Engineer shall review the daily reports submitted by the RPOs, and incorporate a summary of their reports into the weekly report. Any matters requiring action by the Project Manager shall be identified. The report shall include a summary of the quantities of all material installed that week. This report must be completed weekly, summarizing the previous week's activities, and a copy submitted to the Project Manager at the beginning of the following week.

4.1.3 Groundwater Interceptor System Reports

Each Quality Assurance Monitor shall complete a daily report and/or logs on prescribed forms (see Sample CQA Forms in Appendix I) outlining all monitoring activities for that day. The report at a minimum shall consist of field notes, observations, test data sheets, construction problems and solution data sheets. A summary of all supporting data sheets along with final testing or measurements and QAE's approval of the work shall be required upon completion of construction.

The Project Manager shall immediately be made aware of any nonconformance with the project drawings and specifications. In particular, the Project Manager shall be informed before the work in question is covered by subsequent construction activities. The Project Manager shall then determine its cause and recommend appropriate changes. When this type of evaluation is made, the results shall be documented, and any revision to procedures or project specifications shall be approved in writing by the Owner and Designer.

4.2 Test Reports

4.2.1 Soils Testing Reports

Records of field and laboratory testing performed on the soil components for the project shall be collated. A summary list of test results shall be prepared by the CQA Consultant (Engineer) on an ongoing basis, and submitted with the weekly progress reports.

4.2.2 Geosynthetic Testing Reports

The destructive test reports from all sources shall be collated. This includes field tests, Installer's laboratory tests (if performed), and Geosynthetic QAL tests. A summary list of test samples pass/fail results shall be prepared by the CQA Consultant on an ongoing basis, and submitted with the weekly progress reports. The report shall also contain resolution on failed tests clearly documenting complete quality assurance conformance with established procedures.

4.2.3 Groundwater Interception System Testing Reports

Records of field and laboratory testing performed on the components of the groundwater interception system shall be collated by the CQAE. A summary list of test results shall be prepared by the CQAE on an ongoing basis, and submitted with the weekly progress reports.

4.3 Progress Reports

4.3.1 Landfill Cover Progress Reports

The Owner must submit to the U.S. EPA and the OEPA signed monthly progress reports by the middle of each following month during the construction phase. These progress reports must include as a minimum (and as appropriate):

- A description and estimate of the percentage of the RA completed;
- Summary of findings;

- Summary of changes made in the RA during the reporting period;
- Summary of contacts with representatives of the local community, public interest groups, or State government during the reporting period;
- Summary of problems or potential problems encountered during the reporting period;
- Actions being taken to address these problems;
- Changes in key personnel during the reporting period;
- Projected work for the next reporting period;
- Copies of weekly reports, inspection reports, and laboratory/monitoring data (if available);
- Comparisons of working schedule to project schedule; and
- Summaries of conference calls and meetings held during the reporting period between the Respondents and the U.S. EPA and/or the OEPA.

4.3.2 Groundwater Interceptor System Progress Reports

Progress reports shall be prepared by the CQA Engineer and submitted to the Project Manager. These reports shall be submitted every week, starting the first Friday of material delivery or other day as approved by the Project Manager. These reports shall include an overview of progress to date and an outline of any deviation from the project plans or specifications. Revisions to the construction schedule provided by the Contractor will be summarized. The report shall also include any problems or deficiencies in installation at the site, an outline of any action taken to remedy the situation, and a brief description of activities anticipated for the next week. All daily reports for the period should be appended to each progress report.

4.4 Record Drawings

Drawings that document the locations and/or elevations of the remedial actions will be required. The extent and quantity of documentation will vary by feature as discussed below.

4.4.1 Soils Drawings

Record drawings for the Remedial Action shall be prepared by the CQA Consultant and included in the Construction Completion Report. The information shall be presented on scaled drawings both in plan view and in cross-section as necessary. At a minimum, the drawings shall include the following:

- Measured grade spot elevations of the finished surface of each soil component,
- Location of field tests and samples obtained for laboratory testing, and
- Details.

4.4.2 Geosynthetic Drawings

Record drawings shall be prepared by the CQA Consultant (or surveyor under contract to the Owner). The record drawings shall include, at a minimum, the following information for geomembranes:

1. Dimensions of all geomembrane field panels.

2. Location, as accurately as possible, of each panel (panel layout) relative to the site survey grid (State Plane Coordinates) furnished by the Project Manager.

3. Identification of all seams and panels with appropriate numbers or identification codes.

4. Location of all patches and repairs.

5. Location of all destructive testing samples.

The record drawings shall illustrate each layer of geosynthetics and soil, and if necessary, other drawings shall identify problems or unusual conditions of the geosynthetics. In addition, applicable cross sections shall show layouts of geonets, geotextiles, geomembranes or geosynthetic clay liners in areas which are unusual or differ from the design drawings. All surveying for record information shall be performed and stamped by a land surveyor licensed in the State of Ohio.

4.4.3 Groundwater Interception System Drawings

Record drawings shall be prepared by the QAC. The record drawings shall include, at a minimum, the following information for components:

1. Surveyed grade of the base of interceptor trench and cut-off wall.
2. Surveyed grade of the top of rock.
3. Locations of field measurements.
4. Locations of the interceptor trench and cut-off wall alignment at 50' intervals.
5. Locations and elevations of manholes.
6. Locations and elevations of wells and piezometers.
7. Force main and electrical conduit.

If necessary, for the purpose of clarity in the drawings, separate sheets shall be used to illustrate the locations of test sampling points. The drawings shall be shown in both plan and in cross-section views as applicable. All surveying shall be performed by a licensed land surveyor in the State of Ohio.

4.5 Landfill Cover Construction Completion Report

Following the final meeting, a Construction Completion Report shall be prepared by the CQA Consultant and submitted to the Owner for submittal to the U.S. EPA and OEPA. The Construction Completion Report shall confirm and document that the work was performed in substantial compliance with the design plans and specifications. The Construction Completion Report must include the following:

- Parties and personnel involved with the project;

- Scope of work;
- Survey Benchmark information;
- Summary of construction activities;
- Weekly reports;
- Observation and Testing Data Sheets, including sampling locations;
- Test results (conformance, destructive, non-destructive, and other laboratory tests);
- Construction problems and solutions;
- Photographic documentation;
- Changes from design and material specifications;
- Signature page, sealed and signed by the CQA Engineer; and
- Record drawings, sealed and signed by a licensed Professional Engineer, or licensed Registered Land Surveyor in the State of Ohio.

The CQA Engineer shall state in the report that the installation has proceeded in accordance with the CQAP except as noted to the Project Manager. A recommended outline for the final construction completion report is given in Appendix V. The items shown in Appendix V shall be considered the minimum content. The CQA Engineer may expand the content as required.

4.6 Groundwater Interceptor System Final Quality Assurance Report

Upon completion of the work, the QAC shall submit a final Quality Assurance Report to the Project Manager. This report shall summarize the activities of the project, and document all aspects of the quality assurance program performed.

The final Quality Assurance Report shall include, at a minimum, the following information:

1. Parties and personnel involved with the project.
2. Scope of work.
3. Outline of project.
4. Quality assurance methods.
5. Test results (conformance, pressure tests, including laboratory tests).
6. Signature page, sealed and signed by a licensed Professional Engineer.
7. Record drawings, sealed and signed by a licensed Professional Engineer/Surveyor.
8. Weekly reports.
9. Plan and/or specification deviations and resolutions.

The QAC shall state in the report that the installation has proceeded in accordance with the project CQAP except as noted to the Project Manager. See Appendix V for a recommended outline of the final construction completion report. Upon approval by the Project Manager, the Construction Completion Report will be submitted to U.S. EPA and OEPA.

4.7 Final Storage of Records

Final records of the construction of the remediation shall be maintained in the CQA Consultant's files. Copies of reports and other submittals shall be retained by the Owner, the U.S. EPA, and the OEPA.

5.0 FINAL COVER SYSTEM ACCEPTANCE

5.1 Soil Components Acceptance

When the soil components have been constructed in accordance with the design plans and specification as verified by the CQA Engineer, the Project Manager shall consider accepting the soil components of the remedial actions. The Earthwork Contractor will retain all ownership and responsibility for the soil capping components until acceptance by the Project Manager. At the Project Manager's discretion, the system components may be accepted in sections or at points of substantial completion.

The Project Manager will accept the soil components of the capping system when:

1. The installation of the soil components is finished;

2. Verification of the adequacy of the constructed components, including repairs, if any, is completed in accordance with the project-specific CQAP;

3. All documentation of installation is completed; and

4. The CQA Consultant is able to recommend acceptance.

The CQA Engineer shall certify that installation of the soil components has proceeded in accordance with the applicable portions of the project-specific CQAP except as noted to the Project Manager. This certification shall be provided in the final Construction Completion Report as outlined in Section 4.5.

5.2 Geosynthetic Components Acceptance

When the soil components have been constructed in accordance with the design plans and specification as verified by the CQA Engineer, the Project Manager shall consider accepting the geosynthetic components of the lining system. The Installer will retain all ownership and responsibility for the geosynthetics in the lining system until acceptance by the Project Manager. At the Project Manager's discretion, the lining system may be accepted in sections or at points of substantial completion.

The Project Manager will accept the geosynthetic components of the lining system when:

1. The installation of the geosynthetic components is finished;

2. Verification of the adequacy of all seams including associated testing and repairs, if any, is completed in accordance with the project-specific CQAP;

3. All documentation of installation is completed; and

4. The CQA Engineer is able to recommend acceptance.

The CQA Engineer shall certify that installation has proceeded in accordance with the geosynthetic portions of the project-specific CQAP except as noted to the Project Manager. This certification shall be provided in the final Construction Completion Report as outlined in Section 4.5.

5.3 Groundwater Interception System Acceptance

The interception system is an operating system. As such, its acceptance is dependent on its construction in accordance with project documents and successful demonstration of its operation.

5.4 Groundwater Interception System

When the soil components have been constructed in accordance with the design plans and specification as verified by the CQA Engineer, the Project Manager shall consider accepting the soil components of the remedial actions. The Contractor will retain all ownership and responsibility for the components until acceptance by the Project Manager. At the Project Manager's discretion, the system components may be accepted in sections or at points of substantial completion.
The Project Manager will accept the interception system components when:

1. The installation of the interception system components is finished;

2. Verification of the adequacy of the constructed components, including repairs, if any, is completed in accordance with the project-specific CQAP;

3. All documentation of installation is completed;

4. The CQA Consultant is able to recommend acceptance; and

5. After the system has been demonstrated to be in accordance with the project specification.

The CQA Engineer shall certify that installation of the interception system components has proceeded in accordance with the portions of the CQAP except as noted to the Project Manager. This certification shall be provided in the final Construction Completion Report as outlined in Section 4.5.

6.0 SITE PREPARATION

Site Preparation includes:

- Clearing and grubbing the landfill surface and areas along the East Fork of Mill Creek by removing and stockpiling trees, roots, brush, stumps and vegetation, and disposing by hauling to the designated area on site.
- Regrading of exposed debris to conform to cap grades.
- Preparation of groundwater interception system work platform.
- Relocation of fence.
- Installation of fence gates.
- Construction/installation of erosion and sedimentation controls.
- Construction of Diversion Berm.
- Installation of Rip-Rap along East Fork of Mill Creek.

6.1 Observation and Quality Control

Observation and quality control of site preparation includes the following:

- Visual observation and photographic record of the landfill surface following clearing and grubbing.
- Visual observation and photographic record of erosion and sedimentation controls.
- Visual observation and photographic record of debris which was moved to the center of the landfill for cap grading conformance.
- A written record of the surface area cleared and grubbed.

7.0 SUBBASE PREPARATION

Subbase preparation includes:

- Shaping the landfill surface to closely follow (grading tolerence = ±0.1 foot) the subbase contours as illustrated in the design drawings. (Contours are based on achieving a minimum slope of 5% and limiting the grade to a maximum of 33% (3H:1V slope);
- Excavating in-place waste including soil from the two contaminated soil areas, where necessary, and placing the waste in areas of the site receiving the final landfill cover;

7.1 Observation and Quality Control

Observation and quality control of subbase preparation includes:

- Visual and photographic records of the removal and placement of excavated waste.
- Visual and photographic record of the placement of general earthfill used for subbase grading (see Section 9.0).
- Soil testing (field and laboratory as shown on Table 1).
- A written record of the quantities involved for subbase preparation.

7.2 Confirmation

The Earthwork Contractor shall be responsible for preparing the subgrade soil for placement of overlying materials. Upon completion of the subgrade preparation work, the CQA Consultant shall examine the subgrade and prepare a certificate of acceptance to be submitted to the Project Manager. In this certificate of acceptance, the CQA Engineer shall verify, at a minimum, that:

1. A licensed land surveyor in the State of Ohio has verified all lines and grades.
2. The subgrade soil meets the criteria listed in Section 02234, Part 3.03 of the project specifications.

8.0 FINAL COVER

Final cover includes:

Constructing the final cover which is made up of the following components (from top to bottom):

- Vegetative growth
- Vegetative soil cover material
- Geocomposite drainage layer
- 60 mil textured geomembrane
- Geosynthetic clay liner
- Geocomposite gas venting layer

Constructing and shaping the surface water drainage features as specified in the remedial design specifications and design drawings including:

- Perimeter swales
- Interceptor swales
- Rip-rap
- Erosion and sediment control features

8.1 Observation and Quality Control

The CQA Consultant will be present on-site full-time during construction to verify that construction of the final cover system (including surface water drainage features) is in accordance with the remedial design plans and specifications. The CQA Consultant will be responsible for the following items:

- Visually observe soil used for the topsoil, and the vegetative soil cover so that unsuitable soil is not used for these layers;
- Obtain soil samples at a frequency noted on Table 1 for geotechnical laboratory testing;
- Maintain daily field notes regarding project construction;
- Provide photographic record of major construction activities; and
- Survey grade and thickness on 100 foot grid spacing.

8.2 Construction Testing

Both in-field and laboratory testing shall be performed to document materials used and the method of placement as described on the following pages. Sample quantities, containers, preservatives and packaging requirements are summarized in Table 2.

8.2.1 Geocomposite Gas Venting Layer

Perform Conformance testing for the geocomposite as described in Section 12.

8.2.2 Geosynthetic Clay Layer (GCL)

Perform Conformance testing for the GCL as described in Section 10.

8.2.3 Geomembrane Layer

Perform Conformance testing for the geomembrane, as described in Section 11.

8.2.4 Geocomposite Drainage Layer

Perform Conformance testing for the geocomposite as described in Section 12.

8.2.5 Vegetative Soil Cover Material

Vegetative soil cover material generally consists of medium-textured soils capable of supporting vegetative growth and topsoil. Establishment of vegetation reduces cover erosion due to water and wind, and protects the soil and geosynthetic materials against damage. The vegetation also enhances the aesthetic appearance of the landfill.

Site-specific criteria for the vegetative soil cover layer is specified in the project specifications.

No field or laboratory testing is proposed for the general earthfill portion of the vegetative soil cover layer. This soil, which will promote root development, will be placed uncompacted. Field testing of the topsoil portion, which should be the top six (6) inches, will include USDA soil classification by visual observation. Laboratory testing shall be performed at the frequency shown in Table 1 and includes pH, potassium, phosphorus, and total nitrogen.

Verify the actual thickness of the vegetative soil cover using the subgrade and final cover surveyed elevation drawings.

8.3 Failing Tests or Materials

If failing laboratory or field tests occur for any of the final cover system components, the area shall be reworked and retested to achieve passing tests. If the material is incapable of achieving passing results, the material shall be removed and replaced with acceptable material.

8.4 Final Cover Confirmation

Confirmation of the final cover elevations shall be made by direct measurements.

Confirmation of the placement of the various layers shall be made by visual observations and photo documentation.

8.5 Vegetation Confirmation

Confirmation of the vegetation layer shall be made by submittal of seed and fertilizer certifications and bag

tags from products utilized. Confirmation of placement shall be made by visual observations and photo documentation.

8.6 Drainage Features Confirmation

Confirmation of construction and installation of the drainage swales and control structures shall be made by visual observation, photo documentation, and topographic survey of location and elevation.

9.0 GENERAL EARTHFILL

General earthfill will be used as fill material to achieve the proposed subbase grades and vegetative cover soil over the barrier layers. It will be obtained from on-site sources.

9.1 Description and Applicability

General earthfill consists of random, granular or cohesive material taken from on-site, approved off-site excavations or stockpiles and used for non-critical applications. General earthfill material consists of a broad range of soils, relatively free of organics, debris, or other deleterious matter, which can be used for the purpose of earthfill construction. Specific tests to determine the suitability of earth materials for use in general earthfill are specified in the project specifications.

9.2 Quality Control Documentation

Prior to construction of the general earthfill, required tests listed in Table 1 shall be performed to determine conformance with the project specifications. Laboratory testing shall be performed by the Geotechnical QAL. Field density and moisture content testing will be performed by the CQA Consultant.

If required, the general fill material shall be processed such that it does not contain particles exceeding the maximum size established in the project specifications. The Earthwork Contractor shall submit the results of these tests to the Project Manager. The Project Manager shall accept or reject the material based on these tests.

9.3 Construction Observation

The CQA Consultant shall verify that the requirements of the project specifications are met and report any nonconformance to the Project Manager and Contractor.

9.4 Defects and Repairs

9.4.1 Identification

If a defect is identified in the finished general earthfill, the CQA Consultant shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate.

9.4.2 Notification

After determining the extent and nature of the defect, the CQA Engineer shall promptly notify the Earthwork

Contractor and the Project Manager. A work deficiency meeting shall be held as needed between the Earthwork Contractor, CQA Engineer, Design Engineer, Project Manager and other necessary parties to assess the problem, review alternative solutions, and implement an action plan.

9.4.3 Repairs and Retesting

The Earthwork Contractor shall correct all deficiencies to meet the project specifications. If a project specification criteria cannot be met, or unusual weather conditions hinder work, the Design Engineer shall develop and present to the Project Manager suggested solutions for his approval.

The CQA Consultant shall schedule appropriate retests, if required, when the work defect is corrected. Retests by the CQA Consultant must verify that the defect is corrected and work can proceed in the area of the deficiency.

The CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the Project Manager.

10.0 GEOSYNTHETIC CLAY LAYERS

10.1 Definitions and Applicability

Geosynthetic Clay Layers (GCLs) are geocomposite materials that consist of a low hydraulic conductivity montmorillonite-rich expansive clay (bentonite) core which is bonded to a geotextile backing. GCLs are used as barriers in lining and capping systems.

10.2 Manufacturing Plant Inspection

If desired, the Owner or appropriate representative can conduct an inspection of the Geosynthetics Manufacturer's plant. In addition, the Project Manager, or his designated representative, may visit the manufacturing plant for a project-specific inspection if deemed necessary. If possible, the project-specific inspection shall be prior to or during the manufacturing of the GCL rolls for that particular project. The purpose of the plant inspection is to review the manufacturing process and quality control procedures.

The manufacturing plant inspection shall include:

1. Verification that properties guaranteed by the Geosynthetics Manufacturer are met and meet all project specifications.

2. Verification that the measurement of properties by the Geosynthetics Manufacturer is properly documented and test methods used are acceptable.

3. Spot inspection of the rolls and verification that they are free of imperfections or contamination by foreign matter.

4. Review of handling, storage, and transportation procedures, and verification that these procedures will not damage the GCL.

5. Verification that roll packages have a label indicating the name of the Geosynthetics Manufacturer, roll number, and roll dimensions.

6. Verification that overlap lines are printed on the rolls.

10.3 Quality Control Documentation

Prior to the installation of any GCL, the Geosynthetics Manufacturer or Installer shall provide the CQA Consultant with the following information:

1. The origin (supplier's name and location of material source) and identification of the bentonite used for production of the GCL.

2. Copies of dated quality control information issued by the bentonite supplier.

3. Results of quality control tests conducted by the GCL Geosynthetics Manufacturer to verify that the bentonite supplied met the GCL Geosynthetics Manufacturer's specifications.

4. Copies of dated quality control information provided by the geotextile Geosynthetics Manufacturer.

5. A specification for the GCL which includes all properties contained in the project specifications for the GCL.

6. Written certification that the minimum values given in the project specifications are guaranteed by the Geosynthetics Manufacturer.

7. Quality control certificates, signed by a responsible party employed by the Geosynthetics Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for:

    a. Moisture content (ASTM D4643) for every 10,000 ft^2 (1,000 m^2) of material
    b. Hydraulic conductivity (GRI GCL-2) for every 100,000 ft^2 (10,000 m^2) of material
    c. Swell index (GRI GCL-1) for every 10,000 ft^2 (1,000 m^2) of material
    d. Mass per unit area (ASTM D3776) for every 10,000 ft^2 (1,000 m^2) of material

The Geosynthetics Manufacturer shall identify all rolls of GCL with the following:

1. Geosynthetics Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

The CQA Consultant shall review these documents and shall report any discrepancies with the above requirements to the Project Manager and Manufacturer. The CQA Consultant shall verify that:

1. Property values certified by the Geosynthetics Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Geosynthetics Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Rolls are appropriately labeled.

5. Certified minimum properties meet the project specifications.

6. Project specifications and the CQAP were submitted by Project Manager to the Installer.

7. Geosynthetics Manufacturer confirms a field drying shrinkage potential to allow proper seam overlap in the field.

10.4 Conformance Testing

10.4.1 Sampling Procedures

Upon delivery of the rolls of GCL, the CQA Consultant shall examine all rolls and obtain samples for conformance testing. The rolls to be sampled shall be selected by the CQA Consultant. Samples shall not be taken from any portion of a roll which has been damaged. Unless otherwise specified, samples shall be 1 ft (0.3 m) long by the roll width. The CQA Consultant shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the CQA Consultant based on a review of all roll information including quality control documentation and manufacturing records. If the Project Manager desires, the CQA Consultant can perform the conformance test sampling at the manufacturing plant. This may expedite the installation process for remedial action.

Samples shall be taken at a rate of one per lot, not to be less than one per 100,000 ft^2 (10,000 m^2) of GCL. Samples for hydraulic conductivity conformance tests shall be taken at least every 250,000 ft^2 (25,000 m^2). These samples shall then be forwarded to the Geosynthetic QAL for testing to verify conformance to the project specifications.

10.4.2 Conformance Tests

At a minimum, the following conformance tests shall be conducted on the GCL as a unit as required in Section 02245, Part 2.03 of the project specifications.

1. Moisture content (ASTM D4643)
2. Hydraulic conductivity (ASTM D5084)
3. Mass per unit area (ASTM D5993)

10.4.3 Test Results

All conformance test results shall be reviewed and accepted or rejected by the CQA Consultant prior to the deployment of the GCL. The CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the Project Manager. The CQA Engineer shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If the Geosynthetics Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Geosynthetics Manufacturer may request that the sample in question be retested by the Geosynthetic QAL with a technical representative of the Geosynthetics Manufacturer present during the testing. Alternatively, the Geosynthetics Manufacturer may have the sample retested at two different Owner-approved Geosynthetic QALs. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Project Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out-of-specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note

that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out-of- specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

10.5 GCL Deployment

During shipment and storage, the GCL shall be protected from ultraviolet light exposure, moisture, excessive humidity, puncture, cutting, or any other damaging conditions. GCL rolls shall be shipped and stored in relatively opaque and watertight wrappings. GCL rolls shall be stored away from wet ground and be covered with a watertight tarp or under a roof to protect the stored rolls from hydration. The roll wrappings shall be removed shortly before deployment.

The CQA Consultant shall observe rolls upon delivery and prior to deployment at the site and report any deviations from the above requirements to the Project Manager.

Prior to deployment, the Contractor shall prepare and supply to the CQA Consultant, Design Engineer, and Project Manager a panel layout drawing. The CQA Consultant shall review the GCL panel deployment progress and advise the Project Manager on its conformance with the actual field conditions. The CQA Consultant shall verify that the Installer handles the GCL material in such a manner as to not damage the materials, and that the following are complied with:

1. On slopes, the GCL rolls is securely anchored and the GCL material is deployed down the slope in such a manner as to keep the GCL panel in tension.

2. The GCL is installed with the proper side of the material facing upward. The proper orientation of the material is as specified by the manufacturer's specifications.

3. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the GCL.

4. During placement of the GCL, care shall be taken not to entrap beneath the GCL any stones, excessive dust or moisture that could damage the GCL.

5. After installation, a visual examination of the GCL shall be carried out over the entire surface to ensure that no potentially harmful foreign objects, contaminated soil or damaged areas are present.

6. Loss of bentonite on edges during deployment should be minimized.

The CQA Consultant shall verify that no more GCL material is deployed during one working day than can be covered by the end of that day. Exceptions to this requirement may be given by the Project Manager if dry weather is forecast for several consecutive days. GCL deployment shall not be undertaken during precipitation or when there is an immediate threat of precipitation.

The CQA Engineer shall note any noncompliance and report it to the Project Manager.

10.6 Seaming Procedures

10.6.1 Seam Overlap

Adjacent GCL panels shall be joined according to remedial design plans, specifications and manufacturer requirements. At a minimum, the CQA Consultant shall verify the Installer complies with the following requirements:

1. Edge seam overlaps shall be a minimum of 6 in (150 mm).

2. Roll end seam overlaps shall be a minimum 12 in (.3 m).

3. The addition of powdered bentonite to seam locations shall be in accordance with the manufacturer's recommendations.

4. End to end seams on slopes shall be minimized. If they are required, the CQA Engineer shall contact the Design Engineer to verify the method used to attach the GCLs will result in adequate tensile strength.

Prior to approval of the GCL by the CQA Engineer, the following requirements should be visually verified.

1. The required overlaps are provided. The overlap shall be continuously monitored since the panels may be subjected to shrinkage.

2. The amount of the powdered bentonite placed on the seam is as required by the project specifications.

The CQA Engineer shall note any noncompliance and report it to the Project Manager.

10.7 Defects and Repairs

Any portion of the GCL exhibiting flaws shall be repaired. Prior to acceptance of the installed GCL, the Installer and CQA Consultant shall locate damaged areas and the Installer shall complete repairs as directed by the CQA Consultant. Defects or damage can be identified by either rips, tears, premature hydration of the GCL or delamination of the geotextiles.

Rips or tears in the GCL shall be covered by another piece of material meeting the project specifications. The material shall extend over the entire damaged area with a minimum six inch overlap in all directions. Addition of bentonite to patches shall be in accordance with the project specifications.

Where the GCL has been exposed to moisture and has prematurely hydrated prior to placement of overlying material, the material shall be removed and replaced with material meeting the project specifications. All defects and repairs shall be reported to the Project Manager.

10.8 GCL Protection

All soil materials located on top of the GCL shall be deployed in such a manner as to ensure:

1. The GCL is not damaged.
2. Minimal slippage of the GCL on underlying soil layer occurs.
3. No excess tensile stress occurs in the GCL.

Any noncompliance with these guidelines or the project specifications shall be noted by the CQA Engineer and reported to the Project Manager.

11.0 GEOMEMBRANES

11.1 Description and Applicability

Geomembranes are the 60-mil-thick low permeability geosynthetic barriers used in the capping system. This Section is applicable to textured, low density polyethylene geomembranes.

11.2 Manufacturing Plant Inspection

If desired, the Owner or other appropriate representative can conduct an inspection of the Geosynthetics Manufacturer's plant. In addition, the Project Manager, or his designated representative, may visit the manufacturing plant for a project-specific inspection if deemed necessary. If possible, the project-specific inspection shall be prior to or during the manufacturing of the geomembrane rolls for that particular project. The purpose of the plant inspection is to review the manufacturing process and quality control procedures.

A manufacturing plant inspection shall include:

1. Verification that properties guaranteed by the Geosynthetics Manufacturer are met and meet all the project specifications.

2. Verification that the measurement of properties by the Geosynthetics Manufacturer is properly documented and test methods used are acceptable.

3. Spot inspection of the rolls and verification that they are free of imperfections or any sign of contamination by foreign matter.

4. Review of handling, storage, and transportation procedures, and verification that these procedures will not damage the geomembrane.

5. Verification that roll packages have a label indicating the name of the Geosynthetics Manufacturer, type of geomembrane, thickness, roll number, and roll dimensions.

6. Verification that extrusion rods and/or beads are produced from the same base resin type as the geomembrane.

11.3 Quality Control Documentation

Prior to the installation of any geomembrane, the Geosynthetics Manufacturer or Installer shall provide the CQA Consultant with the following information:

1. The origin (supplier's name and production plant) and identification (brand name and number) of the resin used to manufacture the geomembrane.

2. Copies of dated quality control certificates issued by the resin supplier.

3. Results of tests conducted by the Geosynthetics Manufacturer to verify that the resin used to manufacture the geomembrane meets the project specifications.

4. A statement indicating that the amount of reclaimed polymer added to the resin during manufacturing does not exceed the specifications.

5. A list of the materials which comprise the geomembrane, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.

6. A specification for the geomembrane which includes all properties contained in the project specifications measured using the appropriate test methods.

7. Written certification that minimum values given in the remedial design specifications are guaranteed by the Geosynthetics Manufacturer.

8. Quality control certificates, signed by a responsible party employed by the Geosynthetics Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for:

    a. Density (ASTM D1505)
    b. Carbon black content (ASTM D4218)
    c. Carbon black dispersion (ASTM D5596)
    d. Thickness (ASTM D5994)
    e. Tensile properties (ASTM D638)
    f. Puncture resistance (ASTM D4833)
    g. Index friction (GRI GS-7)

    These quality control tests shall be performed in accordance with the test methods for every 50,000 ft^2 (5,000 m^2) of material.

9. Results of environmental stress crack resistance tests (GRI GM-5b). At a minimum, tests shall be performed once every resin lot or every 100,000 ft^2.

The Geosynthetics Manufacturer shall identify all rolls of geomembranes with the following:

1. Geosynthetics Manufacturer's name

2. Product identification

3. Thickness

4. Roll number

5. Roll dimensions

The CQA Engineer shall review these documents and shall report any discrepancies with the above requirements to the Project Manager. The CQA Engineer shall verify that:

1. Property values certified by the Geosynthetics Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Geosynthetics Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Rolls are appropriately labeled.

5. Certified minimum properties meet the project specifications.

6. Project specifications and a copy of the CQAP are provided by the Project Manager to the Installer.

11.4 Conformance Testing

11.4.1 Sampling Procedures

Upon delivery of the rolls of the geomembrane, the CQA Consultant shall obtain samples for conformance testing. The geomembrane rolls to be sampled shall be selected by the CQA Consultant. Samples shall be taken across the entire width of the roll judged by the CQA Consultant not to be damaged. Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The CQA Consultant shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the CQA Engineer based on a review of all roll information including quality control documentation and manufacturing records.

Samples shall be taken at a rate of one per lot and not less than one per 100,000 ft^2 (10,000 m^2) of geomembrane. These samples shall be forwarded to the Geosynthetic QAL for conformance testing for the noted items presented in the following Section.

11.4.2 Conformance Tests

The following conformance tests shall be conducted as required by Section 02406, Part 2.03 of the project specifications:

1. Density (ASTM D1505)
2. Carbon black content (ASTM D4218)
3. Carbon black dispersion (ASTM D5596)
4. Thickness (ASTM D5994)
5. Tensile properties (ASTM D638)

11.4.3 Test Results

All conformance test results shall be reviewed and accepted or rejected by the CQA Engineer prior to the deployment of the geomembrane. The CQA Engineer shall examine all results from laboratory conformance testing and shall report any nonconformance to the Project Manager. The CQA Engineer shall be responsible

for checking that all test results meet or exceed the property values listed in the project specifications.

If the Geosynthetics Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Geosynthetics Manufacturer may request that the sample in question be retested by the Geosynthetic QAL with a technical representative of the Geosynthetics Manufacturer present during the testing. Alternatively, the Geosynthetics Manufacturer may have the sample retested at two different Owner-approved Geosynthetic QALs. If both laboratories produce passing results, the material shall be accepted. If one of the laboratories does not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Project Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out-of-specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting the project specification. This procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line. To isolate the out-of- specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

11.5 Subgrade Preparation

11.5.1 Surface Preparation

The Earthwork Contractor shall be responsible for preparing the underlying soil prior to geomembrane placement. The Project Manager shall coordinate the work of the Earthwork Contractor and the Installer so that the requirements of this CQAP are met.

Before the geomembrane installation begins, the CQA Consultant shall verify that:

1. A licensed land surveyor in the State of Ohio has verified all lines and grades.

2. A qualified and licensed Professional Engineer in the State of Ohio has verified that the underlying GCL meets the criteria specified in the project specifications.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. A certificate of acceptance shall be given by the Installer to the CQA Consultant prior to commencement of geomembrane deployment in the area under consideration. The Project Manager shall be given a copy of this certificate by the CQA Engineer.

After the underlying soil has been accepted by the Installer, it is the Installer's responsibility to indicate to the Project Manager any change in the underlying soil condition that may require repair work. The Project Manager may consult with the CQA Engineer regarding the need for repairs. If the CQA Engineer concurs with the Installer, the Project Manager shall ensure that the underlying soil is repaired.

At any time before or during the geomembrane installation, the CQA Engineer shall indicate to the Project

Manager any locations which may not be adequately prepared for the geomembrane.

11.5.2 Anchor Trench

The CQA Consultant shall verify:

1. The anchor trench has been constructed according to the Remedial Design plans and specifications.

2. If the anchor trench is excavated in a clay material susceptible to desiccation, the amount of trench open at any time should be minimized. The CQA Engineer shall inform the Project Manager of any signs of significant desiccation associated with the anchor trench construction.

3. Rounded corners are provided in the trench so as to avoid sharp bends in the geomembrane.

4. Excessive amounts of loose soil are not allowed to underlie the geomembrane in the anchor trench.

5. The anchor trench is adequately drained by pumping out excess water in the trench to minimize ponding or softening of the adjacent soils while the trench is open.

6. The anchor trench is backfilled and compacted as outlined in the project specifications.

7. Wrinkles occurring near the anchor trench will be minimized by cutting and repairing using methods outlined in Section 02406, Part H of the project specifications.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetic components. The CQA Consultant shall observe the backfilling operation and advise the Project Manager of any problems. Any problems shall be documented by the CQA Consultant in the daily report.

11.6 Geomembrane Deployment

11.6.1 Panel Nomenclature

A field panel is defined as a unit of geomembrane which is to be seamed in the field. A field panel is a roll or a portion of a roll cut in the field. The CQA Consultant shall confirm that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be as simple and logical as possible and shall be agreed upon by the Project Manager, Installer and CQA Consultant.

In general, it is not appropriate to identify panels using roll numbers since roll numbers established in the manufacturing plant are usually cumbersome and are not related to location in the field. The CQA Consultant shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for all quality assurance records.

11.6.2 Panel Deployment Procedure

The CQA Engineer shall review the panel deployment progress of the Installer and advise the Project Manager on its compliance with the approved panel layout drawing. The CQA Engineer shall also review the panel deployment for suitability to actual field conditions such as issues relating to wind, rain, compacted

subgrade soil layer desiccation, and other site-specific conditions. Once approved, only the Project Manager can authorize changes to the panel deployment procedure. The CQA Consultant shall verify that the condition of the underlying soil does not change detrimentally during installation.

The CQA Consultant shall verify that field panels are installed at the locations indicated on the Installer's layout plan, as approved by the Project Manager. The CQA Consultant shall record the identification code, location, and date of installation of each field panel.

11.6.3 Deployment Weather Conditions

Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.

The normal required weather conditions for seaming are as follows:

1. Ambient temperature between 32°F (0°C) and 104°F (40°C).
2. Dry conditions (no precipitation or other excessive moisture).
3. No excessive winds.

The CQA Consultant shall verify that these weather conditions are fulfilled. Ambient temperature shall be measured by the CQA Consultant in the area in which the panels are to be placed.

The CQA Engineer shall inform the Project Manager of any weather-related problems which may not allow geomembrane placement to proceed. The Project Manager will determine if the installation is to be stopped or special procedures are to be used.

11.6.4 Method of Deployment

Before the geomembrane is handled on site, the CQA Consultant shall verify that handling equipment to be used on the site is adequate and does not pose risk of damage to the geomembrane. During handling, the CQA Consultant shall observe and verify that the Installer's personnel handle the geomembrane with care.

The CQA Consultant shall verify the following:

1. Equipment used does not damage the geomembrane by handling.

2. The prepared surface underlying the geomembrane is acceptable immediately prior to geomembrane placement.

3. Geosynthetic elements immediately underlying the geomembrane are clean and free of debris.

4. Personnel do not smoke or wear damaging shoes while working on the geomembrane, or engage in other activities which could damage the geomembrane.

5. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting soil.

6. The method used to place the panels minimizes wrinkles, especially differential wrinkles between adjacent panels.

7. Adequate temporary loading and/or anchoring (such as sand bags or tires), not likely to damage the geomembrane, is placed to prevent uplift by wind. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels.

8. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected. See Section 11.11 for geomembrane protection.

The CQA Engineer shall inform the Project Manager if the above conditions are not fulfilled.

11.6.5 Damage and Defects

Upon delivery to the site, the CQA Consultant shall conduct a surface observation of all rolls for defects and for damage. This examination shall be conducted without unrolling rolls unless defects or damages are found or suspected. The CQA Engineer shall advise the Project Manager, in writing, of any rolls or portions of rolls which should be rejected and removed from the site because they have severe flaws, and/or minor repairable flaws.

The CQA Consultant shall examine each panel, after placement and prior to seaming, for damage and/or defects. The CQA Engineer shall advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, which have been rejected shall be marked and their removal from the work area recorded by the CQA Consultant. Repairs shall be made using procedures described in Section 11.10.

11.6.6 Writing on the Liner

To avoid confusion, the Installer and the CQA Consultant shall each use different colored markers that are readily visible for writing on the geomembrane. The markers used must be semi-permanent and compatible with the geomembrane. The Installer shall use a white marker to write on the geomembrane while the CQA Consultant shall use a yellow marker.

11.7 Field Seaming

11.7.1 Seam Layout

Before installation begins, the Installer shall provide the Project Manager and the CQA Consultant with a panel layout drawing. This drawing shall present all the proposed seams of the lining system at the facility. The CQA Engineer shall review the panel layout drawing and verify that it is consistent with accepted state-of-practice. No panels may be seamed until written approval of the panel layout drawing has been provided by the CQA Engineer. In addition, panels not specifically shown on the panel layout drawing may not be used without the CQA Engineer's prior approval.

In general, seams should be oriented parallel to the line of maximum slope; thus, oriented along and not

across the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 ft (1.5 m) from the toe or crest of the slope, or areas of potential stress concentrations, unless otherwise authorized by the Project Manager.

A seam numbering system compatible with the panel numbering system shall be used by the CQA Consultant.

11.7.2 Accepted Seaming Methods

Approved processes for field seaming are fusion welding and extrusion welding. Proposed alternate processes shall be documented and submitted by the Installer to the CQA Consultant for approval. Only apparatus which have been specifically approved by make and model shall be used.

11.7.2.1 Fusion Process

The CQA Consultant shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances with the project specifications to the Project Manager.

The CQA Consultant shall also verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus agreed upon at the pre-construction meeting.

2. Equipment used for seaming is not likely to damage the geomembrane.

3. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

4. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the geomembrane.

5. A movable protective layer is used as required by the Installer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and to prevent debris from collecting around the pressure rollers.

6. The geomembrane panels are aligned to have an overlap of 4 to 6 inches (100 mm to 150 mm) for fusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

7. No solvent or adhesive is used.

8. The geomembrane is protected from damage in heavy traffic areas.

11.7.2.2 Extrusion Process

The CQA Consultant shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances with the project specifications to the Project Manager.

The CQA Consultant shall verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus agreed upon at the pre-construction meeting.

2. Equipment used for seaming is not likely to damage the geomembrane.

3. Prior to beginning a seam, the extruder is purged until all heat-degraded extrudate has been removed from the barrel.

4. Clean and dry welding rods or extrudate pellets are used.

5. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

6. Grinding is completed no more than one hour prior to seaming except in the case of approaching inclement weather.

7. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs.

8. The geomembrane is protected from damage in heavy traffic areas.

9. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instance shall exposed grinding marks extend more than ¼ in (6 mm) from the finished seamed area.

10. The geomembrane panels are aligned to have a nominal overlap of 3 inches (75 mm) for extrusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

11. No solvent or adhesive is used.

12. The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any temporary welding apparatus is controlled such that the geomembrane is not damaged.

11.7.3 Seam Preparation

The CQA Consultant shall verify that prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the CQA Consultant must verify that the process is completed according to the Geosynthetics Manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane. The CQA Consultant shall also verify that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

11.7.4 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least

once every five hours, for each production seaming apparatus used that day. Trial seams shall be made under the same conditions as production seams.

The trial seam sample shall be at least 5 ft (1.6 m) long by 1 ft (0.3 m) wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Section 11.7.2. Two specimens shall be cut from the sample with a 1 in (25 mm) wide die. The specimens shall be cut by the Installer at locations selected randomly along the trial seam sample by the CQA Consultant.

The specimens shall be tested in peel using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute. They should not fail in the seam as described in Section 11.9.5. If a specimen fails, the entire trial seam operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. The CQA Consultant shall observe all trial seam procedures.

The remainder of the successful trial seam sample shall be retained in the Project Manager's archives for possible laboratory testing. Each sample shall be assigned a number and marked accordingly by the CQA Consultant, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

If agreed upon between the Project Manager and the CQA Engineer, and documented by the CQA Consultant in the daily report, the remaining portion of the trial seam sample can be subjected to destructive testing as indicated in Section 11.9.6. If a trial seam sample fails a test conducted by the Geosynthetic QAL, then a destructive seam test sample shall be taken from each of the seams completed by the seamer during the shift related to the subject trial seam. These samples shall be forwarded to the Geosynthetic QAL and, if they fail the tests, the procedure indicated in Section 11.9.7 shall apply. The conditions of this paragraph shall be considered satisfied for a given seam if a destructive seam test sample has already been taken.

11.7.5 General Seaming Procedures

During general seaming, the CQA Consultant shall verify the following:

1. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 in (150 mm) beyond the cut in all directions.

2. If seaming operations are carried out at night, adequate illumination shall be provided.

3. Seaming shall extend to the outside edge of panels placed in the anchor trench.

4. All cross seam tees should be extrusion welded to a minimum distance of 4 in (100 mm) on each side of the tee.

5. No field seaming shall take place without the Master Seamer being present.

6. A firm substrate may be required to be provided by using a flat board, a conveyor belt, or similar hard

surface directly under the seam overlap to achieve proper support.

The CQA Consultant shall verify that the above seaming procedures or any other procedures agreed upon and indicated in this CQAP are followed, and shall inform the Project Manager of any nonconformance.

11.7.6 Seaming Weather Conditions

11.7.6.1 Cold Weather Conditions

To ensure a quality installation, if seaming is conducted when the ambient temperature is below 32°F (0°C), the following conditions shall be met:

1. Geomembrane surface temperatures shall be determined by the CQA Consultant at intervals of at least once per 100 feet (30 m) of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32°F (0°C).

2. For fusion welding, preheating may be waived by the Project Manager based on a recommendation from the CQA Engineer, if the Installer demonstrates to the CQA Engineer's satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

3. If preheating is required, the CQA Consultant shall observe all areas of geomembrane that have been preheated by a hot air device prior to seaming, to ensure that they have not been overheated.

4. Care shall be taken to confirm that the surface temperatures are not lowered below the minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for the seam area.

5. All preheating devices shall be approved prior to use by the CQA Consultant.

6. Additional destructive tests (as described in Section 11.9) shall be taken at an interval between 250 feet and 500 feet (75 to 150 m) of seam length, at the discretion of the CQA Engineer.

7. Sheet grinding may be performed before preheating, if applicable.

8. Trial seaming, as described in Section 11.7.4, shall be conducted under the same ambient temperature and preheating conditions as the production seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 10°F from the initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature drop.

11.7.6.2 Warm Weather Conditions

At ambient temperatures above 104°F, no seaming of the geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the Project Manager that geomembrane seam quality is not

compromised. Trial seaming, as described in Section 11.7.4, shall be conducted under

the same ambient temperature conditions as the production seams. At the option of the CQA Consultant, additional destructive tests may be required for any suspect areas.

11.8 Nondestructive Seam Testing

11.8.1 Concept

The Installer shall nondestructively test all field seams over their full length using an air pressure test (for double fusion seams only), a vacuum test or other approved method. Air pressure testing and vacuum testing are described in Sections 11.8.2 and 11.8.3 respectively. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

For all seams, the CQA Consultant shall:

1. Observe nondestructive testing procedures.
2. Record location, data, test unit number, name of tester, and outcome of all testing.
3. Inform the Installer and Project Manager of any required repairs.

Any seams that cannot be nondestructively tested shall be cap-stripped with the same geomembrane. The cap-stripping operations shall be observed by the CQA Consultant for uniformity and completeness.

11.8.2 Air Pressure Testing

Air pressure testing is applicable to double fusion welding which produces a double seam with an enclosed space.

1. The equipment for air pressure testing shall consist of the following:

    a. An air pump (manual or motor driven), equipped with pressure gauge and capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa) and mounted on a cushion to protect the geomembrane.
    b. A rubber hose with fittings and connections.
    c. A sharp hollow needle, or other pressure feed device, approved by Project Manager.

2. The following procedures shall be followed:

    a. Seal both ends of the seam to be tested.
    b. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.
    c. Insert a protective cushion between the air pump and the geomembrane.
    d. Pressurize the air channel to a pressure of approximately 30 psi (200K Pa). Close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 5 minutes.
    e. If loss of pressure exceeds the maximum permissible pressure differential as outlined in the project specifications (4 psi) or does not stabilize, locate faulty area and repair in accordance

with Section 11.10.3.

f. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seam the cut end of the air channel.

g. Remove needle or other approved pressure feed device and seal the hole in the geomembrane.

11.8.3 Vacuum Testing

Vacuum testing is applicable to extrusion welding.

1. The equipment shall consist of the following:

   a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.
   b. A pump assembly equipped with a pressure controller and pipe connections.
   c. A rubber pressure/vacuum hose with fittings and connections.
   d. A soapy solution. (CQA Consultant shall verify that the solution bubbles when air is passed through.)
   e. A bucket and wide paint brush, or other means of applying the soapy solution.

2. The following procedures shall be followed:

   a. Wet a strip of geomembrane approximately 12 in x 48 in (0.3 m x 1.2 m) with the soapy solution.
   b. Place the box over the wetted area.
   c. Close the bleed valve and open the vacuum valve.
   d. Verify that a leak-tight seal is created.
   e. Energize the vacuum pump and reduce the applied pressure to approximately 5 psi (10 in of Hg/35 kPa) gauge.
   f. For a minimum of 10 seconds, apply vacuum with the box placed and maintaining a seal, examine the geomembrane through the viewing window for the presence of soap bubbles.
   g. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in (75 mm) overlap, and repeat the process.
   h. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 11.10.3.

11.8.4 Test Failure Procedures

The Installer shall complete any required repairs in accordance with Section 11.10. For repairs, the CQA Consultant shall:

1. Observe the repair and testing of the repair.
2. Mark on the geomembrane that the repair has been made.
3. Document the repair procedures and test results.

11.9 Destructive Seam Testing

11.9.1 Concept

The purpose of destructive tests is to evaluate seam strength. Destructive seam tests shall be performed at selected locations. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

11.9.2 Location and Frequency

The CQA Consultant shall select where seam samples will be cut out for laboratory testing. The frequency and locations shall be established as follows:

1. A minimum frequency of one test location per 500 ft (150 m) of seam length performed by each welding machine. This frequency is to be determined as an average taken over the entire geomembrane lined area.

2. Test locations shall be determined during seaming at the CQA Consultant's discretion. Special consideration shall be given to locations where the potential for imperfect welding, such as overheating, contamination, and offset welds exists.

The Installer shall not be informed in advance of the locations where the seam samples will be taken.

11.9.3 Sampling Procedures

Samples shall be cut by the Installer at locations chosen by the CQA Consultant as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The CQA Consultant shall:

1. Observe sample cutting.

2. Assign a number to each sample, and mark it accordingly.

3. Record sample location on layout drawing.

4. Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

Repair all holes in the geomembrane resulting from destructive seam sampling in accordance with repair procedures described in Section 11.10.3 immediately following receipt of successful test results. Test the continuity of the new seams in the repaired area according to Section 11.8.3.

11.9.4 Sample Dimensions

At each sampling location, two types of samples shall be taken by the Installer. First, two specimens for field testing should be taken. Each of these samples shall be cut with a 1 in (25 mm) wide die, with the seam centered parallel to the width. The distance between these two samples shall be 42 in (1.1 m). If both

samples pass the field test described in Section 11.9.5, a sample for laboratory testing shall be taken.

The sample for laboratory testing shall be located between the samples for field testing. The sample for laboratory testing shall be 12 in (0.3 m) wide by 42 in (1.1 m) long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

1. One 12 in wide x 18 in long (0.3 m x 0.5 m) portion for Geosynthetic QAL testing.

2. One 12 in wide x 12 in long (0.3 m x 0.3 m) portion to the Installer for optional laboratory testing.

3. One 12 in wide x 12 in long (0.3 m x 0.3 m) portion to the Project Manager for archive storage.

11.9.5 Field Testing

The two 1-in (25 mm) wide specimens mentioned in Section 11.7.4 and Section 11.9.4 shall be tested in the field using a tensiometer for peel adhesion and shall not fail according to the criteria as outlined in Section 02406, Part F(2) of the project specifications. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it fails, the seam should be repaired in accordance with Section 11.9.7. Final judgement regarding seam acceptability, based on the failure criteria provided in the project specifications, rests with the CQA Engineer.

The CQA Consultant shall witness all field tests and mark all samples and portions with their number. The CQA Consultant shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

11.9.6 Laboratory Testing

Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the CQA Consultant in a manner which will not damage the test sample. The sample shall be shipped as soon as possible to expedite laboratory testing. The Project Manager will be responsible for storing the archive samples. Test samples shall be tested by the Geosynthetic QAL.

Testing shall include seam strength and peel adhesion (ASTM D4437). The minimum acceptable values to be obtained in these tests are provided in the project specifications (see Appendix II). At least 5 specimens from each sample shall be tested, each in both shear and peel. Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear). A passing test shall meet the minimum acceptable values in at least 4 of the 5 specimens tested for each method.

The Geosynthetic QAL shall provide test results within 24 hours of receiving the samples. The CQA Engineer shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Project Manager.

11.9.7 Destructive Test Failure

When a sample fails a destructive test, whether that test is conducted by the Geosynthetic QAL or by field tensiometer, the Installer has two options:

1. The Installer can repair the seam between any two passing destructive test locations; or

2. The Installer can trace the welding path to an intermediate location 10 ft (3 m) minimum from the point of the failed test in each direction and take a sample with a 1 in (25 mm) wide die for an additional field test at each location. If these samples pass, then full laboratory samples are taken. If these laboratory samples pass, then the seam is repaired between these locations. If any samples fail, then the process is repeated to establish the zone in which the seam should be repaired.

All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests of trial seam samples taken as indicated in Section 11.7.4 may be used as a boundary for the failing seam. In cases exceeding 150 ft (50 m) of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Section 11.10.
The CQA Consultant shall document all actions taken in conjunction with destructive test failures.

11.10 Defects and Repairs

11.10.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the CQA Consultant for identification of defects, holes, blisters, undispersed raw materials, large wrinkles and any sign of contamination by foreign matter. The geomembrane surface shall be cleaned by the Installer prior to examination if the CQA Consultant determines that the amount of dust or mud inhibits examination.

11.10.2 Evaluation

Each suspect seam area shall be nondestructively tested using the methods described in Section 11.8. Each location which fails the nondestructive testing shall be marked by the CQA Consultant and repaired by the Installer. Work shall not proceed with any materials which will cover locations which have been repaired until successful nondestructive and/or laboratory tests are obtained.

When seaming of the geomembrane is completed, and prior to placing overlying materials, the CQA Consultant shall indicate any large wrinkles which should be cut and reseamed by the Installer. The number of wrinkles to be repaired should be kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation period, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over on to itself which is generally a wrinkle that extends 12 in (0.3 m) from the subgrade. Seams produced while repairing wrinkles shall be nondestructively tested.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, the final cover should be placed during the coolest weather. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the CQA Consultant to verify that wrinkle formation is minimized and that, in all cases, the geomembrane is not folded over on itself.

11.10.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Installer, and CQA Engineer.

1. The repair procedures available include:

    a. Patching, used to repair holes, tears, undispersed raw materials, and contamination by foreign matter.
    b. Spot welding used to repair pinholes, or other minor, localized flaws.
    c. Capping, used to repair large lengths of failed seams.
    d. Extrusion welding the flap, used to repair areas of inadequate fusion seams which have an exposed edge. Repairs of this type shall be approved by the CQA Consultant and shall not exceed 100 ft (30 m) in total length.
    e. Removing bad seam and replacing with a strip of new material welded into place.

2. For any repair method, the following provisions shall be satisfied:

    a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be ground no more than one hour prior to the repair.
    b. All surfaces shall be clean and dry at the time of the repair.
    c. All seaming equipment used in repairing procedures shall meet the requirements of this CQAP.
    d. Patches or caps shall extend at least 6 in (150 mm) beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 in (75 mm).

11.10.4 Repair Verification

The CQA Consultant shall observe all nondestructive testing of repairs and shall record the number of each repair, date and test outcome. Each repair shall be nondestructively tested using the methods described in Section 11.8 as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 ft (50 m) long require destructive test sampling. Failed tests require that the repair shall be redone and retested until a passing test results.
When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. The placement of cover materials shall be observed by the CQA Consultant to verify that wrinkle formation is minimized and that, in all cases, the geomembrane is not folded over on itself.

11.11 Geomembrane Protection

The quality assurance procedures indicated in this Section are intended only to assure that the installation of adjacent materials does not damage the geomembrane. The quality assurance of the adjacent materials themselves are covered in separate Sections of this CQAP.

11.11.1 Soils

A copy of the project specifications prepared by the Design Engineer for placement of soils shall be given

to the CQA Engineer by the Project Manager. The CQA Engineer shall verify that these project specifications are consistent with geosynthetic state-of-practice such as:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32°F (0°C) nor above 104°F (40°C) unless otherwise specified.

2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.

3. Equipment used for placing soil shall not be driven directly on the geomembrane.

4. A minimum cover thickness of 1 ft (0.3 m) of soil is required for a light dozer, ground pressure of 5 psi (35 kPa) or lighter, to travel over the geomembrane.

5. A minimum cover thickness of 3 ft (0.9 m) of soil is required for heavy construction equipment over 5 psi to travel over the geomembrane. This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

The CQA Consultant shall measure soil thickness and verify that the required thickness is present. The CQA Consultant must also verify that final thickness is consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage is unlikely. The CQA Engineer shall inform the Project Manager if the above conditions are not fulfilled.

12.0 GEOCOMPOSITE GAS VENTING AND DRAINAGE LAYERS

12.1 Definition and Applicability

Geocomposites are geotextile and geonets used as a filter and drainage media in lining and capping systems. This section is applicable to venting drainage geocomposites made of polyester or polypropylene non-woven geotextiles and high density polyethylene (HDPE) geonet. The geotextiles may be bonded to both sides of the geonet for the drainage layer and the gas venting layer.

12.2 Manufacturing Plant Inspection

If desired, the Owner or appropriate representative may conduct an inspection of the geocomposite Geosynthetics Manufacturer's plant. In addition, the Project Manager, or his designated representative, may visit the manufacturing plant for a project-specific inspection if deemed necessary. If possible, the project-specific inspection shall be prior to or during the manufacturing of the geocomposite rolls for that particular project. The purpose of the plant inspection is to review the manufacturing process and quality control procedures.

A manufacturing plant inspection shall include:

1. Verification that the proper quality control documentation has been received by the Geosynthetics Manufacturer from the component Geosynthetics Manufacturers.

2. Verification that properties guaranteed by the Geosynthetics Manufacturer are met and meet requirements outlined in Section 02418 of the project specification.

3. Verification that the measurement of properties by the Geosynthetics Manufacturer is properly documented and test methods used are acceptable.

4. Spot inspection of the rolls and verification that they are free of imperfections or contamination by foreign matter.

5. Review of packaging, handling, storage, and transportation procedures and verification that these procedures will not damage the geocomposite.

6. Verification that roll packages have a label indicating the name of the Geosynthetics Manufacturer, type of geocomposite, roll number, and roll dimensions.

12.3 Quality Control Documentation

Prior to the installation of any geocomposite, the geocomposite Geosynthetics Manufacturer or Installer shall provide the CQA Consultant with the following information:

1. The origin (supplier's name and production plant) and identification (brand name and number) of the geotextile and geonet used to fabricate the geocomposite.

2. Copies of dated quality control certificates issued by the geotextile and geonet supplier. These certificates shall contain the results of the quality control tests performed on the geocomposite.

3. A specification for the geocomposite which includes all properties published by the Geosynthetics Manufacturer measured using the appropriate test methods.

4. Written certification that minimum values given in the specification are guaranteed by the Geosynthetics Manufacturer.

5. Quality control certificates for the geocomposite, signed by a responsible party employed by the Geosynthetics Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures and results of quality control tests. At a minimum, results shall be given as outlined in Section 02418, Part 2.01(A), (B) and (C), including:

   a. Mass per unit area (ASTM D3776)
   b. Thickness (ASTM D1777)
   c. Geotextile-geonet adhesion (ASTM D413)

   Quality control tests shall be performed in accordance with the test methods for at least every 40,000 ft^2 (4,000 m^2) of geocomposite produced.

The Geosynthetics Manufacturer shall identify all rolls of geocomposite with the following:

1. Geosynthetics Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

The CQA Engineer shall review these documents and shall report any discrepancies with the above requirements to the CQA Consultant. The CQA Engineer shall verify that:

1. Property values certified by the Geosynthetics Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Geosynthetics Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum roll properties meet the project specifications.

6. Project specifications and this CQAP were submitted by the Project Manager to the Installer.

12.4 Conformance Testing

12.4.1 Sampling Procedures

Upon delivery of the rolls of geocomposite, the CQA Consultant shall obtain samples for conformance testing. The rolls to be sampled shall be selected by the CQA Consultant. Samples shall not be taken from any portion of a roll which has been damaged. Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The CQA Consultant shall mark the machine direction on the samples with an arrow. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the CQA Consultant based on a review of all roll information including quality control documentation and manufacturing records.

Unless otherwise specified, samples shall be taken at a rate of one per lot, not to be less than one per 100,000 ft^2 (10,000 m^2) of geocomposite. These samples shall then be forwarded to the Geosynthetic QAL for testing to ensure conformance with the project specifications.

12.4.2 Conformance Tests

At a minimum, the following conformance tests shall be performed on the geocomposite as a unit:

1. Mass per unit area (ASTM D3776)
2. Geotextile-geonet adhesion (ASTM D413)

12.4.3 Test Results

All conformance test results shall be reviewed and accepted or rejected by the CQA Engineer prior to the deployment of the geocomposite. The CQA Engineer shall examine all results from laboratory conformance testing and shall report any nonconformance to the Project Manager. The CQA Engineer shall check that all test results meet or exceed the property values listed in the project specifications.

If the Geosynthetics Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Geosynthetics Manufacturer may request that the sample in question be retested by the Geosynthetic QAL with a technical representative of the Geosynthetics Manufacturer present during the testing. Alternatively, the Geosynthetics Manufacturer may have the sample retested at two different Owner-approved Geosynthetic QALs at the expense of the Geosynthetics Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the CQA Consultant.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out-of-specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one

manufacturing line). To isolate the out-of-specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

12.5 Geocomposite Deployment

During shipment and storage, the geocomposite shall be protected from ultraviolet light exposure, moisture, mud, dirt, dust, puncture, cutting, or any other damaging conditions. Geocomposite rolls shall be shipped and stored in relatively opaque and watertight wrappings. The roll wrappings shall be removed shortly before deployment.

The CQA Consultant shall verify that the geonet is free of dirt and dust prior to installation. The CQA Consultant shall identify any dirty rolls and report them to the Project Manager. If the geonet is judged to be dirty or dusty by the CQA Consultant, it shall be cleaned by the Installer prior to installation. Any washing operation shall be observed by the CQA Consultant and improper washing operations shall be reported to the Project Manager.

The CQA Consultant shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Project Manager.

The Installer shall handle all geocomposite in such a manner as to ensure they are not damaged, and the following shall be complied with:

1. On slopes, the geocomposite shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.

2. In the presence of wind, all geocomposites shall be weighted with sandbags or the equivalent. Sandbags shall be installed during deployment and shall remain until replaced with cover material.

3. Unless otherwise specified, single-sided geocomposite shall not be welded to the geomembrane.

4. Geocomposites shall be cut using a hook blade or other tool approved by the CQA Consultant. If in place, special care shall be taken to protect underlying geosynthetics from damage which could be caused by the cutting of the geocomposite. Care shall be taken not to leave the tools in the geocomposite.

5. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.

6. During placement of geocomposite, care shall be taken not to entrap in or beneath the geocomposite stones or dirt that could damage the underlying geomembrane, cause clogging of drains or filters, or hamper subsequent seaming. If dirt or excess dust is entrapped in the geonet of single-sided geocomposite, it should be washed clean prior to placement of the next material on top of it. In this regard, care shall be taken with the handling of sandbags, to prevent puncturing the sandbag.

7. A visual examination of the geotextile component of the geocomposite shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects are present.

The CQA Consultant shall note any noncompliance and report it to the Project Manager.

12.6 Seaming Procedures

In general, no horizontal seams shall be allowed on sideslopes. Thus, seams shall be along, not across, the slope, except as part of a patch. If horizontal seams are required, they shall be offset from adjacent horizontal seams.

At a minimum, the following requirements shall be met:

1. Adjacent geocomposite shall be overlapped so that the geonet overlaps by at least 4 in (100 mm) and geotextiles overlap by at least 3 in (75 mm).

2. Where geotextiles (two sided geocomposite or the geotextile) overlap, seam geotextile together.

3. The geonet overlaps shall be tied with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.

4. Tying shall be every 5 ft (1.5 m) along the slope, every 6 in (150 mm) in the anchor trench, and every 12 in (150 mm) along end-to-end seams on the base of the landfill.

5. In the corners of the sideslopes where overlaps between perpendicular strips are required, an extra layer shall be unrolled along the slope, on top of the previously installed geocomposite, from top to bottom of the slope.

6. When more than one layer of geocomposite is installed, joints shall be staggered.

7. Once geonet is tied, the geotextile of the geocomposite shall be seamed. On slopes shallower than 10H:1V, geotextiles shall be sewn (preferred), or thermally bonded with the written approval of the CQA Consultant. The Installer shall pay particular attention to seams to ensure that no earth cover material could be inadvertently inserted beneath the geotextile.

8. Any sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Sewing shall be done using machinery and stitch types specified in the project specifications or as approved in writing by the CQA Engineer.

The CQA Consultant shall note any noncompliance and report it to the Project Manager.

12.7 Defects and Repairs

12.7.1 Identification

If a defect is identified in the geocomposite, the CQA Consultant shall determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by additional tests, observations, a review of records and other means that the CQA Engineer deems appropriate.

12.7.2 Notification

After determining the extent and nature of the defect, the CQA Consultant shall promptly notify the Installer and Project Manager. A work deficiency meeting shall be held as required between the Installer, CQA Engineer, Design Engineer, Project Manager and any other necessary parties to assess the problem, review alternative solutions, and implement an action plan.

12.7.3 Repair Procedures

The final decision as to the appropriate repair shall be agreed upon between the Project Manager, Installer, Design Engineer, and CQA Engineer. Prior to acceptance of the geocomposite, the Installer shall locate and repair all damaged areas as directed by the CQA Consultant. Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile. The CQA Consultant shall observe any repair and report any noncompliance with the requirements in writing to the Project Manager.

If in the CQA Consultant's judgement, the defect is determined to be small, typically smaller than 3 by 3 feet, the geocomposite shall be repaired as follows:

1. If the geonet is judged to be undamaged but the geotextile is damaged, a patch of geotextile shall be placed over the damaged area. The geotextile patch shall be thermally bonded in place with a minimum of 12 inch (0.3 m) overlap in all directions.

2. If the geonet is judged to be damaged, the damaged geonet shall be removed. A section of geonet shall be cut to replace the removed section. The geonet shall overlap the removed section by 6 inches in all directions and be tied to the existing geonet using white plastic fasteners placed at least every 6 inches (150 mm). A geotextile patch shall be placed over the repaired geonet section. The geotextile patch shall be thermally bonded in place with a minimum of 12 inch (0.3 m) overlap in all directions.

If in the CQA Consultant's judgement, the defect is determined to be large, typically larger than 3 by 3 feet, the geocomposite roll shall be replaced.

The CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the Project Manager.

12.8 Geocomposite Protection

For single-sided geocomposites, soils should never be placed in direct contact with the geonet. All soil materials located on top of the geocomposite shall be deployed in such a manner as to ensure:

1. The geocomposite and underlying lining materials are not damaged.
2. Minimal slippage of the geocomposite on underlying layers occurs.
3. No excess tensile stresses occur in the geocomposite.

Any noncompliance with these guidelines or the project specifications shall be noted by the CQA Consultant and reported to the Project Manager.

13.0 PASSIVE GAS VENTS AND GAS PROBES

The CQA Consultant will verify that the vents and probes meet project specifications as outlined in Section 13.1 of this plan. The Passive gas vents include:

- Perforated PVC pipe set in a gravel-filled trench. The trench placed in the top of the waste is approximately 1 foot deep, 2 feet wide and 6 feet long, and interfaces with the geocomposite gas venting layer of the final cover.
- Geomembrane pipe boot to provide a seal for the geomembrane primary barrier around the pipe.
- Turbine gas vent cap.

Gas probes include:

- Perforated PVC pipe set in a gravel filled borehole that extends approximately 20 feet below ground surface.
- Bentonite surface seal.
- Protective outer steel casing.

13.1 Observation and Quality Control

Observation and quality control of the passive gas vents include:

- Visual and photographic records of the excavation into the subbase and waste, if encountered, and disposal of the waste.
- Visual and photographic records of the installation of the PVC vent pipe including pipe perforations and gravel backfill.
- Visual and photographic records of placing the geocomposite gas venting layer around the vent pipe and over the gravel backfill.
- Visual and photographic records of the placement of the final cover around the vent pipe including installation and welding of the geomembrane pipe boot.
- Visual and photographic record of the completed vent.

Observation and quality control of the gas probes include:

- Visual and photographic record of the drilling and gas probe pipe installation.
- Visual and photographic record of the bentonite surface seal.
- Visual record of the protective steel casing pipe installation.

13.2 Confirmation

Confirmation of gas vent and probe construction shall be made by:

- Survey locations of the vents and probes.
- Visual observation and photographic record of the construction effort.
- Visual observation of the relocation of excavated waste.
- Classification of aggregate materials.

14.0 EXCAVATION FOR THE GROUNDWATER INTERCEPTION TRENCH

The excavation for the interception trench and cut-off wall will be performed using the slurry trench method of construction.

14.1 Description and Applicability

The intent of the groundwater interception trench is to intercept and collect the flow of ground water as it moves through the stratigraphy from the landfill and buried lagoon toward the East Fork of Mill Creek. The grades identified on the drawings indicate the required depth for the interception trench bottom. Ground water will flow, by gravity, through the interception alignment to a sump located at the "low" end of each interception trench. For this reason, the slope identified for the bottom of the trench must be adhered to.

14.2 Quality Control Documentation

Prior to the construction of the groundwater interception system, the interception trench, cut-off wall, and force main must be staked in the field to provide the locational verification required to address constructability. This will allow for minor adjustments in the alignments to avoid obstacles or account for any unforeseen field conditions. Field survey stakes shall be placed at fifty (50) foot intervals.

14.3 Construction Observations

As the trench is excavated, survey measurements shall be taken to the bottom of the excavation. These depth measurements shall be taken at twenty-five (25) foot intervals. All measurements shall be compared to remedial design drawing elevations and the grade/slope from the last point calculated. Elevations shall also be recorded at the top of the trench, adjacent to the trench, so that depth can be calculated. A profile of the trench top and bottom will be required at the completion of the project.

Where rock in encountered as part of the excavation for the interception system, the top of rock elevation will be taken at twenty-five (25) foot intervals in addition to the information identified above.

At the ends of the trenches, the QAC will verify that the trench has reached full depth at the design location for the starting point and ending point of the trench. Additional measurements will also be taken to ensure that the sump is constructed to at least the minimum dimensions shown on the remedial design drawings.

15.0 GEOTEXTILE

A geotextile wrap is provided for the granular material in the interceptor trench.

15.1 Description and Applicability

The geotextile lines the sides of the interceptor trench to filter out fines that could flow into the trench and foul the granular drainage material. The geotextile is continuous down the side of the trench, across the bottom and up the opposite side. The two ends of the geotextile are to be overlapped at the top of the trench. The geotextile sheets shall also be overlapped along the length of the trench to assure complete coverage of the soil trench interface.

15.2 Conformance Testing

The manufacturer will be required to provide certification that the material meets the design specifications. The QAE will review the certifications and compare them with the required specifications for the material. Deviations will be recorded and the Project Manager informed.

The QAC will also perform transmissivity testing on the geotextile to verify that water will pass thru the geotextile and satisfy the design criteria stated in the specifications. Additionally, the gradient ratio or long term soil fabric filtration test will be performed to verify that the geotextile will not be clogged by the soil particles. These tests will be run at the frequency of two tests per manufacturer's lot.

15.3 Construction Observation

The QAC will provide full time observation of the installation of the geotextile. Additionally, the QAC will verify overlaps, observe the geotextile installation to identify procedures or processes that may cause the geotextile to become folded or otherwise not cover the soil trench interface. The QAC will also observe the tension on the geotextile during the placement of granular material, to determine the potential for tearing the geotextile. Lastly, the QAC will verify the geotextile in the sump locations does not contain any seams in the geotextile.

16.0 GRANULAR DRAINAGE MATERIAL

16.1 Description and Applicability

The granular drainage material has been sized and specified for the collection trench such that design flows are maintained for the ground water through the trench, and so the material will not react with the leachate. For this reason it is important that the material installed meet the specification requirements. The granular drainage material will be installed inside of the geotextile wrap, within the trench.

16.2 Conformance Testing

One test shall be performed per source to verify the carbon content and a test performed to verify the gradation of the material. These tests shall be performed prior to the material being delivered to the site. A verification of the gradation will be performed on the material delivered to the site to ensure that the material previously tested is delivered to the site.

The QAC personnel will be responsible for verifying that the material conforms with the specifications.

16.3 Construction Observation

The QAC will observe material delivered to the site and identify any variation in the material. If variations are observed, additional tests may be performed at the discretion of the Project Manager.

The QAC will observe the granular material as it is placed to ensure that the material is not fouled by other materials in handling. Additionally, the QAC will observe the material as it is placed into the trench and identify any procedures or processes that could harm the Geotextile. The top elevation of the granular material will be recorded at twenty-five (25) foot intervals.

17.0 EXTRACTION AND INSPECTION WELLS AND PIEZOMETERS

The extraction and inspection wells will be installed within the interceptor trench. The piezometers will be located on either side of the trench.

17.1 Description and Applicability

The location of the extraction wells has been established to coincide with the low point of each interceptor trench. It is imperative that the well extend into the sump and within six (6) inches of the bottom of the sump. Additionally, a pump will be placed in the well and will need to reach the bottom of the well. For this reason, the wells must be installed at the correct location and the well must be installed vertically with minimal lateral displacement.

17.2 Conformance Testing

The materials delivered to the site will be inspected for damage and for the manufacturer and product specification stamp. These markings will be checked against the remedial design specifications before the material will be approved by the QAC.

17.3 Construction Observation

The QAC personnel will observe the installation of the extraction and inspection wells. The QAC will observe the installer to ensure that the contractor places granular material on all sides of the well during the backfilling operation. Additionally, the depth of the well being installed will be recorded. After installation, the height of the well above grade will be recorded. The depth of the well will be calculated based on the length of casing and screen installed. This depth will be compared to the surveyed depth. Variations will be brought to the Project Managers attention.

18.0 BIO-POLYMER SLURRY

The Bio-Polymer slurry will be used for construction of the interceptor trench.

18.1 Description and Applicability

The Bio-Polymer Slurry will be required to maintain the stability of the side walls of the interception trench during the trench excavation process. The Slurry will allow for the placement of the geotextile, the granular material and the wells. After installation of the interceptor trench, the slurry will be degraded or broken by slurry modifiers. This will allow the trench to achieve the design permeability and the soils adjacent to the trench assume their original hydraulic conductivity.

18.2 Conformance Testing

The contractor shall submit physical and chemical characteristics and properties of the Bio-Polymer to be used. Additionally, the contractor shall submit test data to document these properties for both the Bio-Polymer Slurry and the degraded slurry. MSDS's shall be submitted to the QAC for the Bio-Polymer materials and should be on site prior to or at the time of delivery.

18.3 Construction Observation

The contractor will be required to perform the following tests at the on-site construction trailer or other suitable quarters at the identified frequencies:

Viscosity	4 per shift,
Density	4 per shift,
pH	4 per shift and
Filtrate Loss	1 per shift.

This data shall be provided to the QAC as it is obtained.

19.0 CUT-OFF WALL EXCAVATION

The cut-off wall will be constructed using a soil-bentonite slurry.

19.1 Description and Applicability

The cut-off wall will run along an alignment that parallels the stream alignment. The wall will extend down to and be embedded in the bedrock along its length. The purpose of the wall is to prevent the flow of ground water from the site toward the East Fork of Mill Creek, and from the creek back toward the interceptor trench.

19.2 Conformance Testing

The manufacturer of the bentonite and any additives shall provide manufacturer certificates of compliance for these materials to the QAC. The materials delivered to the site will be verified by comparing the shipping ticket with the manufacturer's certification.

Additionally, the contractor will be required to submit slurry mix designs and trial mix reports using soils from the site as outlined in Section 02395, Part 1.06 of the project specifications. This data will be reviewed for compliance with Section 2.01, Part (A)(1) and (2) of the project specifications prior to the initiation of construction.

19.3 Construction Observation

The QAC will observe the preparation of the slurry at the site, and verify that it complies with the trial mix procedures. In addition, the QAC will perform the tests identified in the Table 1 of Section 02395, Part 3.04(A)(2) of the project specifications.

20.0 INTERCEPTION SYSTEM FORCE MAIN

The force main will convey groundwater collected in the interceptor trench to the sanitary sewer.

20.1 Description and Applicability

The force main is a 2-in HDPE pipe designed to carry groundwater, under pressure, from the interceptor trench to the existing sanitary sewer. The length of force main which extends from north of the trench to the sanitary sewer tie-in (outside of the interceptor trench/cut-off wall) will be encased within a 4-in PVC secondary containment pipe, as indicated on the drawings of Section 2.0 of the Design report.

20.2 Conformance Testing

Pressure tests shall be conducted in the presence of the QAC to verify the integrity of the constructed force main. Equipment shall be provided to supply water, pressure (including a regulator set to avoid overpressuring pipe), and to monitor pressure and temperature. The section of pipe to be tested shall be plugged, filled with water (vented at high points to purge air pockets while filling), and pressurized to at least 150 percent of design operating pressure (but not less than 50 psi).

The applied pressure will be allowed to stabilize, and temperature and pressure will be monitored for a period of not less than 1-hr. At the end of the test period, the end of the tested segment opposite the pressure gauge will be vented and the gauge monitored to assure continuity of the tested segment.

A pressure loss of not more than 1 percent of the applied pressure during the test period will be considered acceptable.

In the area where a containment pipe is required, the containment pipe will also be pressure tested.

20.3 Construction Observation

The QAC will observe and document the following:

1. Date of test.
2. Description and identification of piping system tested.
3. Type of test performed.
4. Test fluid.
5. Test pressure.
6. Type and location of leaks detected.
7. Corrective action taken to repair leaks.
8. Results of retesting.

TABLES

TABLE 1

CONSTRUCTION DOCUMENTATION SOILS TESTS AND FREQUENCY
SKINNER LANDFILL

Test Type	Test Method	Test Frequency
General earthfill (subbase only):		
o Field density and moisture content	ASTM D2922	2 tests/acre/lift
o Moisture-density relationship (Standard Proctor)	ASTM D689	1/material type
o Grain-size distribution (sieve and hydrometer)	ASTM D1140, D422	3/material type
o Atterberg Limits	ASTM D4318	3/material type
Topsoil (post-construction):		
o pH, nitrogen, phosphorous, and potassium		1 per 10 acres
o USDA soil classification		Visual
o Survey - grade and thickness		100 ft grid

TABLE 2

SAMPLE QUANTITIES, CONTAINERS, PRESERVATIVES, AND PACKAGING REQUIREMENTS
SKINNER LANDFILL
GEOTECHNICAL TESTING

Analysis	Container	Preservation	Holding Time	Volume of Samples	Shipping	Normal Packaging
Moisture-Density Relationship/Moisture Content	Sealed Plastic Bag or Bucket	None	None	10 to 15 lbs	Regular mail	
Atterberg Limits	5 gal plastic bucket	None	None	Fill bucket	Regular mail	
Grain-size distribution	5 gal plastic bucket	None	None	Fill bucket	Regular mail	
Permeability	5 gal plastic bucket	None	None	Fill bucket	Regular mail	
Gradation determination	5 gal plastic bucket	None	None	Fill bucket	Regular mail	
pH, Nitrogen, Phosphorous, and Potassium	2 8-oz glass jars	None	None	Fill jars	Regular mail	Vermiculite

TABLE 3

MATERIALS QUALITY CONTROL PROGRAM
SOIL/BENTONITE
SLURRY TRENCH CUT-OFF WALL

MATERIALS				
SUBJECT	STANDARD	TYPE OF TEST	MINIMUM FREQUENCY	SPECIFIED VALUES
Water	--	- pH - Total Hardness	Per water source or as changes occur	As required to properly hydrate bentonite with approved additives
Additives	--	Manufacturer certificate of compliance	One per truckload	As approved by Engineer
Bentonite	API Std 13A	Manufacturer certificate of compliance	One per truckload	Premium grade sodium cation montmorillonite
Backfill soils	--	Selected soils approved by the Engineer	One per source	Consistent with Design Mix
Prepared for placement into the trench	API Std 13B	- Unit Weight - Viscosity - Filtrate	2 set per shift or per batch (pond) One per truckload	Unit weight $\geq$ 1.03 gm/cc V $\geq$ 15 centipose or 40 sec-Marsh @ 68° Loss $\leq$ 30 cc in 30 min @ 100 psi
SLURRY				
In Trench	API Std 13B 1	- Unit Weight	2 per shift at point of trenching	Unit weight = 1.03-1.50 gm/cc
BACKFILL MIX				
At Trench	ASTM C 138 ASTM C 143 ASTM D 422 EM-1110-2-1906	- Unit Weight - Slump - Gradation - Permeability	2 per shift	15 pcf $\geq$ slurry density Slump 2 to 6 inches Consistent with Design Mix K $\leq 10^{-7}$ cm/sec

The results of all field testing done will be recorded on field report tables and retained for the final documentation report.

TABLE 4

BIO-POLYMER SLURRY
CONSTRUCTION DOCUMENTATION TESTS AND FREQUENCY
SKINNER LANDFILL

Test Type	Test Frequency
Bio-Polymer Slurry:	
o Density	4 tests/shift
o Viscosity	4 tests/shift
o pH	4 tests/shift
o Filtrate Loss	1 test/shift

APPENDIX I

SAMPLE CQA FORMS

E A R T H T E C H

Daily Summary of Site Activities

Site: _____ Project No.: _____

Date: _____ Time Work Began: _____ Time Work Ended: _____

Staff:	Type	No.	Organization	Hours

Equipment:	Present	Utilized (Y/N)

Work Completed: _____

Comments: _____

Future Plans: _____

Prepared By: _____

Page _____ of _____

EARTH TECH

Construction Photo Log

Sheet ____ of ____

Project: _____ Project No.: _____

	Date Taken	Picture No.	Description
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

Notes: _____

EARTH TECH

Field Density Test Report
(Nuclear Density Test)

Date: _____ Project: _____ Page ____ of ____

Daily Report No.: _____ Project No.: _____

Technician: _____ Computer Entry: _____ Computer Backcheck: _____

Test Number	Retest Ref. No.	Location and Description	North Coordinate	East Coordinate	Elevation (Ft.)	Soil Description	Probe Depth (Inches)	Wet Density (Pcf)	Dry Density (Pcf)	Moisture (Pcf)	Moisture (%)	Proctor (Pcf)	% Com-paction

Comments: _____

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EARTH TECH

Geosynthetic Materials Inventory Checklist

T11.828

Project Name: ______________________ Date: ______________________

Client: ______________________ Material Type: ______________________

Project No.: ______________________ Manufacturer: ______________________

Lot Number	Roll Number	Dimensions	Condition

Totals:

Notes: ______________________

EARTH TECH

Certificate Of Acceptance
Of Soil Subgrade By Installer

Installer _____ Location _____

Authorized Representative _____ Project _____

Owner _____

I the Undersigned, duly authorized representative of _____

do hereby accept the Soil Subgrade surface and shall be responsible for its integrity and suitability, in accordance with these specifications from this date to completion of the installation.

_____

Name Signature Title

_____

Date

Certification Accepted By – RUST Environment & Infrastructure Inc.

_____

Name Signature Title

_____

Date

_____

Geomembrane Panels Placed

EARTH TECH

Panel Placement Information

Client: _____ Page ____ of ____

Date: _____ Project: _____ Computer Entry: _____

Daily Report No.: _____ Project No.: _____ Computer Backcheck: _____

Time	Panel Identification			Batch/Roll Number	Deployed Panel Length	Station		Observer	Comments/Damage
	Layer	Number	Location			Beg.	End		
				Total Length					

EARTH TECH

Trial Weld Information

Client: _____ Page ____ of ____

Date: _____ Project: _____ Computer Entry: _____

Daily Report No.: _____ Project No.: _____ Computer Backcheck: _____

Time	AMB Temp	Sample ID	Seamer ID	Machine ID	Extrusion Welds		Fusion Welds		Peel PPI			Shear PPI	Observer	Comments
					Barrel Temp	Preheat Temp	Wedge Temp	Wedge Speed						

EARTH TECH

Panel Seaming Information

Page ____ of ____

Client: _____

Date: _____ Project: _____ Computer Entry: _____

Daily Report No.: _____ Project No.: _____ Computer Backcheck: _____

Start Time	Seam ID	Seam Location	Seamer ID	Machine ID	Station		Seam Length	Observer	Comments
					Beg.	End			

Total: _____

EARTH TECH

Nondestructive Seam Testing Information

Client: _____ Page ____ of ____

Date: _____ Project: _____ Computer Entry: _____

Daily Report No.: _____ Project No.: _____ Computer Backcheck: _____

Seam Number ID	Seam Location	Station		Test Crew	Air Testing					Vacuum Test P/F	Observer	Comments
					Time		Pressure					
		Beg.	End		Beg.	End	Beg.	End	P/F			

EARTH TECH

Destructive Seam Sample Log

Client: _____ Page ____ of ____

Date: _____ Project: _____ Computer Entry: _____

Daily Report No.: _____ Project No.: _____ Computer Backcheck: _____

Sample Number	Date Sampled	Seam ID	Location	Seamer ID	Machine ID	Field Test Peel	Field Test (PPI)	Lab P/F	Sample Reason / Comments

Client: _____ Page ____ of ____

Date: _____ Project: _____ Computer Entry: _____

Daily Report No.: _____ Project No.: _____ Computer Backcheck: _____

Date Repaired	Repair Number	Seam ID	Panel(s)	Location	Description of Damage	Type/Size of Repair	Repair Crew	Date Tested	Tested By	Observer	Comments

EARTH TECH

Daily Field Report Geosynthetics Summary

Project No.: _____ Report No. _____

Page _____ of _____

Date: _____

I. INSTALLED QUANTITIES

Material	SF Today	SF Total

II. FUSION SEAMING

Mouse	LF Today	LF Total

III. EXTRUSION SEAMING

Tech.	Gun	LF Today	LF Total

IV. DESTRUCTIVE SAMPLES MARKED

DS	Seam	Station

V. COMMENTS

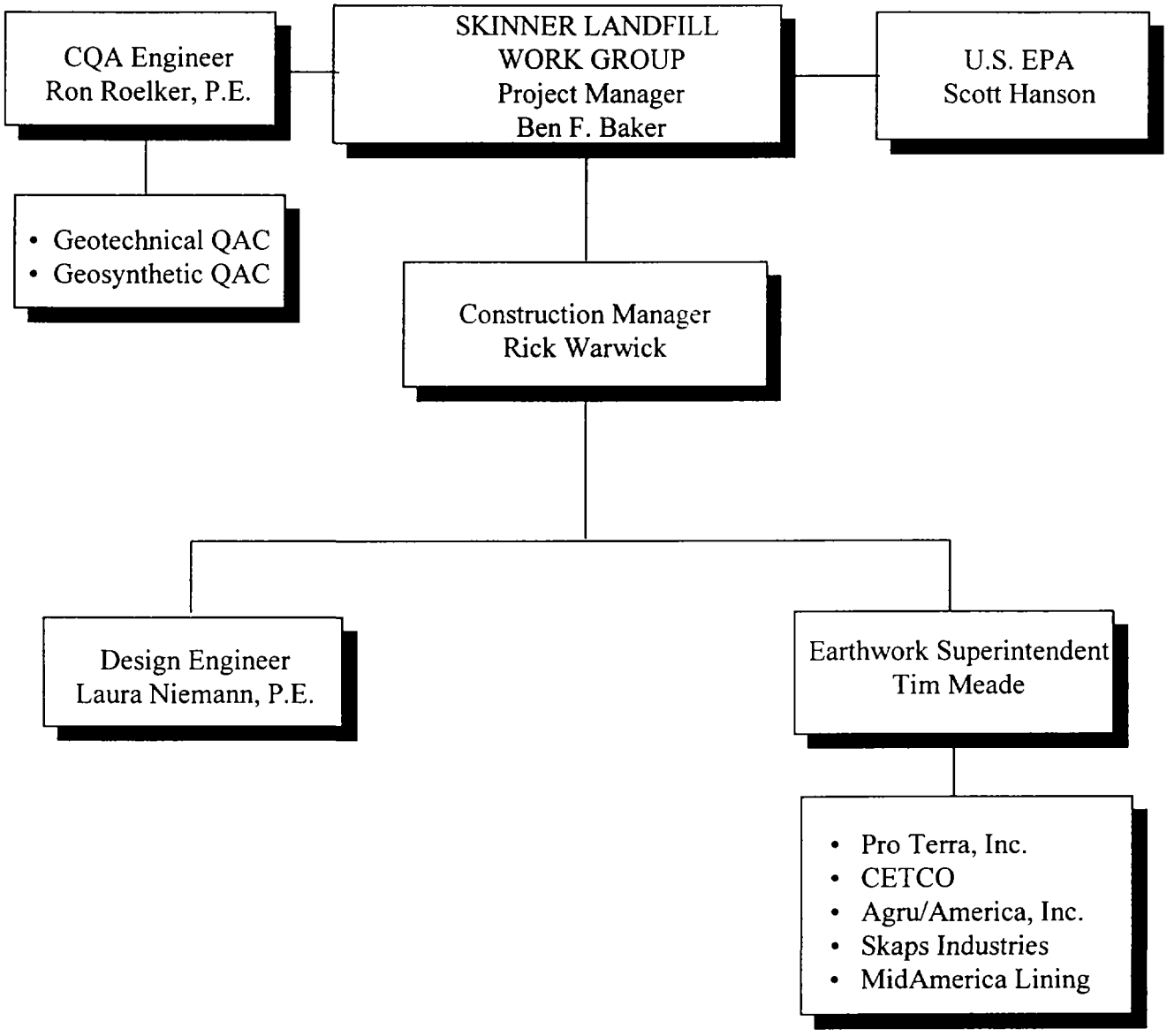
Signature: _____

White Copy - Library File Yellow Copy - Owner Pink Copy - Employee's Field File

APPENDIX II

LINES OF COMMUNICATION

Appendix II
LINES OF COMMUNICATION



Appendix III
RESOLUTION MEETING AGENDA
EXAMPLE

1. Introductions

    A. Assign Minute Taker
    B. Identify Parties
        1. Project Manager
        2. Design Engineer
        3. CQA Engineer/RPO
        4. Interception System QAC
        5. Owner representative
        6. Others

2. Tour Project Site

3. Review Documents

    A. Project Plans
        1. Design Drawings
        2. Support Plans
    B. Project Specifications
    C. Construction Quality Assurance Manuals
    D. Permit Documents

4. Construction Quality Assurance Plan

5. Discuss Contract Administration and Construction Issues

6. Define Lines of Communication

7. Define Project Deliverables

8. Determine Schedule

Appendix IV
PRE-CONSTRUCTION MEETING AGENDA
EXAMPLE

1. Introductions

   A. Assign Minute Taker
   B. Identify Parties
      1. Project Manager
      2. Design Engineer
      3. Surveyor
      4. Earthwork Contractor
      5. Geosynthetic Installation Contractor
      6. Interception System Contractor
      7. Interception System Trench QAC
      8. Engineer/RPO
      9. Owner representative
      10. U.S. EPA Representative
      11. OEPA Representative
      12. Driller
      13. Subcontractors
      14. Others

2. Tour Project Site

3. Review Documents

   A. Project Drawings
   B. Project Specifications
   C. Geosynthetic Panel Layout
   D. Construction Quality Assurance Plans
   E. Health and Safety Plan
   F. SPCC Plan
   G. Air Monitoring Plan
   H. Contingency Plan

4. Define Lines of Communication

   A. Lines of Communication
   B. Reporting Methods
   C. Distribution Methods
   D. Progress Meetings
   E. Procedures for Approving Design Clarifications and Changes During Installation

Appendix IV (Continued)
PRE-CONSTRUCTION MEETING AGENDA
EXAMPLE

F. Procedures for Approving Earthwork, Geosynthetics, Other Materials and Groundwater Interception System
G. Procedures for Resolution of Construction Problems

5. Review Site Requirements

A. Safety Rules
B. Site Rules
C. Work Schedule
D. Storage of Materials
E. Available Facilities

6. Discuss Construction Issues

A. Scope of Work
B. Review Design
   1. Project Drawings
   2. Specifications
   3. Geosynthetic Panel Layout
C. Construction Procedures
   1. Proposed Construction Sequencing
   2. Location of Soil Stockpile Areas
   3. Location of Geosynthetic Storage Area
   4. Location of Interception System Material Storage Area
   5. Equipment
D. Construction Schedule
E. Procedures for Preparing and Approving Change Orders
F. Health and Safety Plan
G. Progress Reports

7. Select Testing Equipment, Review Sampling and Testing Procedures

8. Review Construction Quality Assurance Plan

A. Soils
B. Geosynthetics
C. Drainage Systems

Appendix IV (Continued)
PRE-CONSTRUCTION MEETING AGENDA
EXAMPLE

D. Wells and Piezometers
E. Groundwater Interception System

9. Establish Project Deliverables

A. Responsibilities
   1. Owner
   2. Design Engineer
   3. Project Manager
   4. Geosynthetics Installation Contractor
   5. Earthwork Contractor
   6. Interception System Contractor
   7. CQA Engineer and RPO
   8. Interception System QAC
   9. Surveying Services
B. Distribution of Deliverables
C. Approval Procedures
D. Minutes of Meetings from the Project Manager (purpose, distribution)

Appendix V
FINAL CONSTRUCTION COMPLETION REPORT
GENERAL OUTLINE

1. Introduction

    A. Purpose
    B. Scope
    C. Unit Description
    D. Project Parties

2. Project CQAP

    A. Scope
    B. Design Changes
    C. Project-Specific Addenda
    D. Permit Conditions
    E. Regulations (ARAR's)

3. Work Performed

    A. Weather Constraints
    B. Pre-construction Testing
    C. Conformance Testing
    D. Visual Monitoring
    E. Photo Documentation
    F. Construction Testing
    G. Repairs

4. Discussion of Construction Problems and Resolutions including Design changes.

5. Summary and Conclusions

6. Project Certification Statement

7. Appendices

    A. Key Project Personnel including:
        1. Owner
        2. Design Engineer Personnel
        3. CQA Consultant Personnel
        4. Earthwork Contractor Personnel

Appendix V (Continued)
FINAL CONSTRUCTION COMPLETION REPORT
GENERAL OUTLINE

5. Geosynthetic Installation Contractor Personnel
6. Groundwater Interception Personnel
7. Driller Personnel
8. Surveyor
9. U.S. EPA Personnel
10. OEPA Personnel

B. Construction Quality Assurance Plan (CQAP) with Project-Specific Addenda
C. Design Change Forms
D. Earthwork Testing Records
E. Conformance Testing Records
F. Geosynthetics Manufacturer Quality Control Records
G. Quality Assurance Reports
H. Subgrade Acceptance Certificates
I. Panel Placement and Seaming Records
J. Trial Weld Records
K. Non-Destructive Seam Testing Records
L. Destructive Seam Testing Records
M. Repairs
N. Record Drawings
O. Photo Records
P. Boring Logs
Q. Well Construction Drawings
R. Pump Control Settings